Textile Texts

Third Edition
1907

presented by
Draper Company
Hopedale, Mass.

R. HAMMOND

ARTHUR S. BROWNE
WASHINGTON TRUST BUILDING
WASHINGTON, D. C.

To Our Customers,

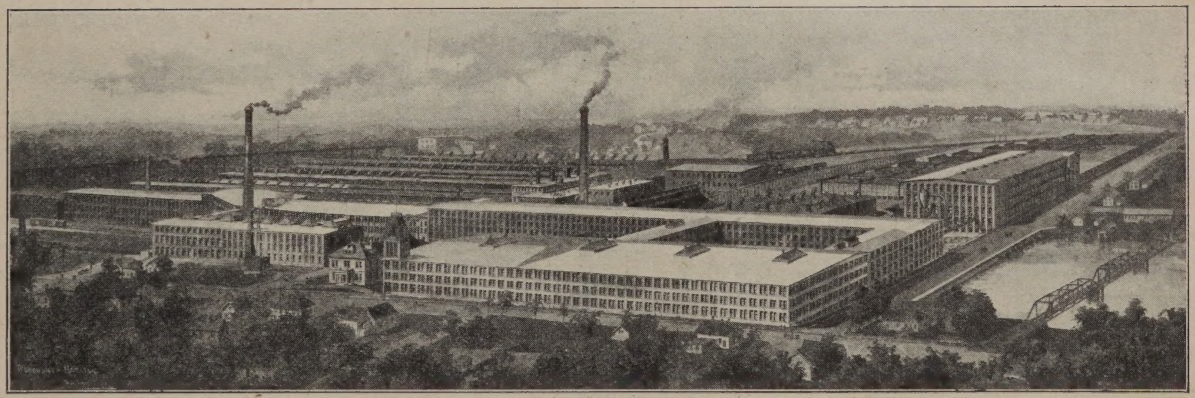
The Cotton Manufacturers of the United States,

WHOSE ENTERPRISE IN

TESTING AND ADOPTING VALUABLE IMPROVEMENTS IN MACHINERY HAS STIMULATED THE DEVELOPMENT OF IMPORTANT INVENTIONS, THUS IMPROVING THE QUALITY AND DIMINISHING THE COST OF THE FABRICS PRODUCED,

THIS, OUR ELEVENTH DESCRIPTIVE CATALOGUE,

Is Respectfully Dedicated.



PLANT OF DRAPER COMPANY, HOPEDALE, MASS., 1907.

TEXTILE TEXTS

FOR

COTTON MANUFACTURERS,

CONCERNING THE

PROPER METHODS OF EQUIPPING AND RUNNING MILLS,

INCLUDING SPECIAL TREATISES ON

CARDING, SPINNING, SPOOLING,

WARPING, DYEING, REELING,

TWISTING AND WEAVING.

ALSO

GENERAL HISTORY, MATHEMATICAL TABLES,

AND A FULL LIST OF THE

PATENTED COTTON MACHINERY

INTRODUCED AND SOLD BY

DRAPER COMPANY.

AS THIS WORK HAS BEEN REVISED MORE OR LESS, IT WILL BE KNOWN IN THE PRESENT FORM AS THE

THIRD, OR 1907 EDITION.

PRESENTED WITH THEIR COMPLIMENTS.

HOPEDALE, MASS., U. S. A.,

1907.

Copyright 1907,

BY DRAPER COMPANY.

Written and Compiled by

GEORGE OTIS DRAPER.

DATES OF ISSUE OF GEO. DRAPER & SONS' CATALOGUES.

1st—1871—50 pages.
2d—1872—66 pages.
3d—1873—75 pages.
4th—1876—66 pages.
5th—1881—126 pages.
6th—1887—214 pages.
7th—1893—80 pages. (No advertising, mostly tables.)
8th—1896—272 pages.

DATES OF ISSUE OF DRAPER COMPANY COMPLETE CATALOGUES.

1st (corresponding to 9th)—1901—320 pages.
2d (corresponding to 10th)—1903—340 pages.
3d (corresponding to 11th)—1907—356 pages.

Printed by

MILFORD JOURNAL COMPANY,

MILFORD, MASS.

PREFACE.

The business now under control of DRAPER COMPANY, a corporation organized under the laws of the state of Maine in 1896, was taken over from former Hopedale Corporations and firms, on January 1st, 1897. The original industry was established early in the century, the following chronological table showing the gradual changes:

1816—IRA DRAPER. Started taking out loom patents.

1830—JAMES DRAPER, (son of Ira) purchased loom and temple business.

1837—JAMES & E. D. DRAPER formed partnership.

1839—Important patent on temple improvement granted to GEORGE DRAPER.

1842—Transfer of E. D. DRAPER'S business to Hopedale, Mass.

1852—E. D. & G. DRAPER formed partnership, selling Temples, Let-off Motions, etc.

Firm of E. & W. W. DUTCHER started selling temples.

1854—W. W. DUTCHER & CO. succeeded E. & W. W. Dutcher, E. D. & G. Draper having acquired the interest of Elihu Dutcher.

1856—HOPEDALE MACHINE CO. and HOPEDALE FURNACE CO. organized.

1856—Dutcher temples first made in Hopedale.

1867—HOPEDALE MACHINE COMPANY chartered.

1867—DUTCHER TEMPLE COMPANY chartered.

1867—HOPEDALE FURNACE COMPANY chartered.

1868—Partnership of GEO. DRAPER & SON replaced that of E. D. & G. DRAPER, E. D. Draper retiring in favor of Wm. F. Draper, first son of George Draper.

1877—Partnership name changed to GEO. DRAPER & SONS, on admission of George A. Draper, second son of George Draper.

1880—Eben S. Draper, third son of George, admitted to GEO. DRAPER & SONS.

1880—Consolidation of HOPEDALE FURNACE COMPANY with HOPEDALE MACHINE COMPANY. Large additions in progress.

1886—Incorporation of the town of HOPEDALE as distinct from the town of MILFORD, of which it was formerly a part.

1887—Wm. F. Draper, Jr., first son of Wm. F. Draper, admitted to GEO. DRAPER & SONS. Death of George Draper occurred same year. Firm name unchanged.

1888—HOPEDALE MACHINE SCREW COMPANY chartered.

1889—George Otis Draper, second son of Wm. F. Draper, admitted to GEO. DRAPER & SONS.

1892—NORTHROP LOOM COMPANY chartered.

1896—Plant of the HOPEDALE ELASTIC GOODS COMPANY purchased by the HOPEDALE MACHINE COMPANY, for necessary enlargement of business.

1897—DRAPER COMPANY absorbed

GEO. DRAPER & SONS,
THE HOPEDALE MACHINE COMPANY,
THE DUTCHER TEMPLE COMPANY,
THE HOPEDALE MACHINE SCREW COMPANY,

and took over the United States rights of the NORTHROP LOOM COMPANY and the agency for the SAWYER SPINDLE COMPANY.

1899—Started on plan of alteration to double total output.

1900—DRAPER COMPANY took rank as the largest American producer of cotton machinery, with the largest plant and the largest number of operatives.

1902—Plant at this date completely altered and united to increase output, centralize power plant and economize manufacture.

1902—BRITISH NORTHROP LOOM COMPANY LIMITED organized to furnish looms in certain Foreign countries.

1904—DRAPER COMPANY ranking second in number of patents acquired in the country yearly.

1905—Large addition to plant to accommodate bobbin industry.

1907—Organization of DRAPER COMPANY now comprises the following officers:—

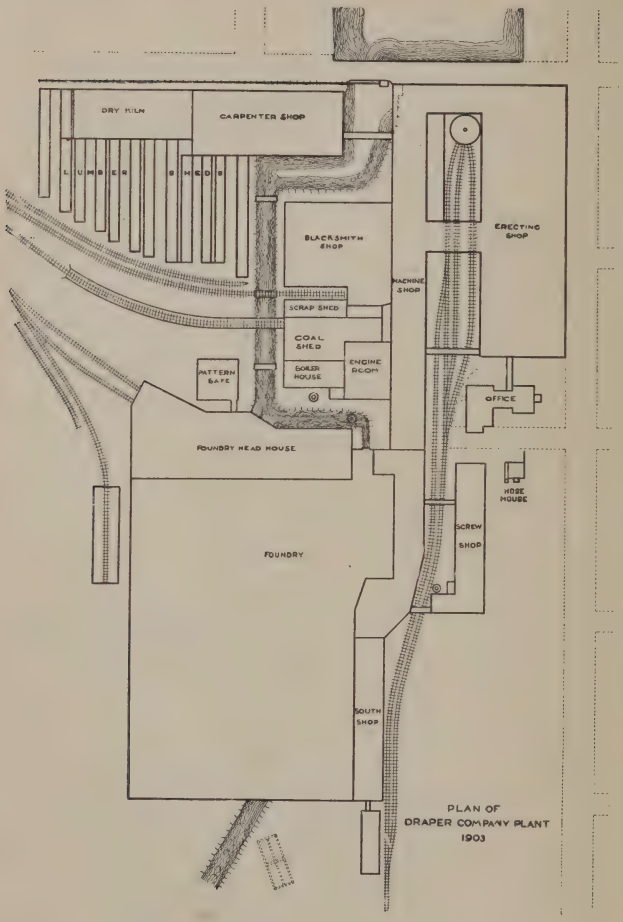
William F. Draper, President.
Joseph B. Bancroft, Vice-President.
George A. Draper, Treasurer.
Eben S. Draper, Agent.
George Otis Draper, Secretary.
E. D. Bancroft, Purchasing Agent.
Frank J. Dutcher, Assistant Agent.
J. D. Cloudman, Southern Agent.
Charles E. Nutting, General Superintendent.
C. H. Draper, Patent Specialist.

Directors—William F. Draper, Joseph B. Bancroft, Geo. A. Draper, Eben S. Draper, George Otis Draper, E. D. Bancroft, Frank J. Dutcher, C. H. Draper, C. E. Nutting.

OUR LOCATION.

Our works are situated in the country village of Hopedale, Mass., adjoining the large town of Milford, of which we were formerly a part. A straight line between Boston and New York would bisect us at a point less than thirty miles from the former city. While off of the main line of railroad we have branch connections to Boston from Milford via South Framingham on the Boston & Albany, (N. Y. Central) route and via Franklin to Boston on the N. Y., N. H. & H. route. **Purchase tickets at South Station, Boston, for Milford, Mass.,** and take hack from Milford to our office, or walk up Central Street, Milford, and take trolley to Hopedale. Parties coming from New York can change at South Framingham for Milford, if taking the B. & A. route on such trains as stop at South Framingham. Connections can be made by other trains and other routes through Boston, Providence or Worcester. The Grafton & Upton R. R. connects Hopedale with Worcester (19 miles), through North Grafton on the B. & A., and while it handles our freight at night, it runs a trolley service during the day. Connections are also made with trolley for Worcester at North Grafton. Providence (26 miles) connections are made either through Franklin by the N. Y., N. H. & H. route or by Woonsocket via Bellingham Junction on the Boston & Pascoag route, or by trolley either to Uxbridge or Woonsocket, where connections are made on the Providence and Worcester division of the N. Y., N. H. & H. R. R. Trolley cars passing our office run directly to South Framingham, (13 miles), in one direction and to Uxbridge (6 miles), Upton (5 miles), Grafton (10 miles)and North Grafton (13 miles) in the other, and connect at Milford with trolley lines to Woonsocket (13 miles), Franklin (10 miles), Medway (7 miles), Hopkinton (5 miles) and points beyond.

Telegrams are telephoned to us from the Milford office of the Western Union Co. If addressed to Hopedale they will reach us properly. Our long distance telephone call is Milford 26-13, 3 and 14.



OUR HOPEDALE PLANT IN 1907.

Scale 312 feet to the inch.

As here shown the buildings have over 27 acres of floor space, including their several stories. The various departments are designed to allow still further additions without displacing their relative positions.

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We show above our medal granted at the St. Louis Exposition for an exhibit representing our various tenement-house designs. We have also received medals from Expositions in Paris and Liege on these same buildings.

LATEST STATISTICS.

Since preparing the earlier pages of statistics certain information has come to light that merits printing:

Estimate of Cotton Spindles in

United States near close of 1906—	25,810,000
Germany,	9,730,000
France,	6,700,000
Austria,	3,620,000
Italy,	3,500,000
Portugal,	350,000
India,	5,250,000
Japan,	1,400,000
Mexico,	730,000

We only give those changes showing larger quantities than given on page 18.

The cotton crop for 1905-06 figured in statistical bales of 500 pounds net weight is 10,919,000 bales, according to "Cotton Facts."

Col. Shepperson estimates the United States consumption of cotton for season ending Aug. 31st, 1906, as 4,603,000 bales of 500 pounds net, being 428,000 more than last season. Mr. Thomas R. Ellison estimates British consumption for the season ending Sept. 30th, as 3,774,000, or 154,000 more bales than the previous season. He estimates continental consumption as 5,252,000 bales, being 104,000 more than the previous season. All estimates on bales are 500 pounds net. The continental consumption is exclusive of Asiatic consumption, and the American consumption is exclusive of Egyptian and Peruvian cotton. During the season, 82,683 bales of Egyptian and 17,128 bales of Peruvian were imported.

The American crop proved much larger than generally estimated, exceeding the estimates of the Southern Cotton Association according to Col. Shepperson, by 1,800,000 bales, and the United States Department of Agriculture by about 800,000 bales. We can readily understand the conservatism of the Cotton Association, but the Government should be able to come nearer the actual facts, if it intends to give the facts.

While leading experts anticipate a still further increase in consumption of cotton by the mills of the world, the crop of 1906-07 will more than suffice to meet the demand, providing present estimates of 13,000,000 American bales is fairly accurate.

Any prices quoted in this catalogue are subject to change without notice.

BUYING COTTON.

The Arkwright club has recently adopted the following buying rules. The question of allowance for tare has been under discussion in their meetings for many years, but they still adhere to the twenty-two pound maximum.

RULES FOR BUYING COTTON.

1. The weight of bagging and ties shall not exceed 22 pounds per bale, and claims shall be made on the excess over that weight.

2. Claims for extra tare shall be good for 15 months from purchase of cotton.

3. The average allowance for loss of weight on any one mark of cotton shall not exceed three pounds per bale, with cotton in sound and dry condition.

4. Country-damaged cotton will not be received.

5. The weights on Bills of Lading must agree with the invoice weights.

6. Bills of Lading containing clauses giving the carrier the benefit of insurance will not be accepted.

7. Bills of Lading containing clauses limiting the time in which suit for loss or damage shall be instituted will not be accepted.

8. Cost of insurance in excess of all rail rates on cotton *via* Gulf ports will be charged to shippers. The marine rates are allowed on shipments from Atlantic states *via* Atlantic ports by steamer.

9. The shipper's brand should be stenciled on each bale.

IT is our purpose to make this book a compendium of useful information for everyone connected with the manufacture of cotton cloth or yarns. While some of our specialties are equally applicable to woolen, worsted and silk manufacture, we feel that the cotton mill is our legitimate field of action and broad enough to require the greater part of our time. In connection with the general information furnished, we introduce descriptions of our machinery, and rules and tables of great interest to the practical manufacturer. These tables in many cases are merely the results of mathematics and formulæ, and have been published by us before. Others, however, are figured from actual results gathered from hundreds of mills, and properly averaged. The latter are of great practical value. In this present edition, new tables are presented whenever the conditions have made such change necessary.

This book is copyrighted, and we hope to see that copyright respected. We expect to issue a sufficient number of copies so that all men occupying responsible positions in Cotton Mills may have them on demand.

DRAPER COMPANY.

COTTON MANUFACTURING.

Human necessity has developed three great fundamental industries, namely: The feeding, the sheltering, and the clothing of the human species. There are other branches, of course, such as transportation and various lines of manufacture which furnish objects of use and interest for varied purpose. The supplementary necessities of higher civilization, however, were not evolved until the primal wants were gratified. It is in the manufacture of clothing that human ingenuity is best illustrated, and particularly in that sub-division including textile manufactures. Many of the methods of producing food are but slightly advanced over early processes. The cow and the hen are not perceptibly more productive than in the days of the Patriarchs, and the spade and the hoe are still popular. In the buildings that shelter the race is also exemplified a continued use of ancient implements, such as the trowel, hammer, and saw. When we investigate the textile industry, however, we find that present production is based on inventions of modern creation, they having multiplied the product per operative to a point beyond that attained in any other large division of human employment.

All textile manufacture starts with the making of yarn, which is an elongated mass of fibre, the continuity of which depends upon the frictional engagement of short fibres with others of similar kind. These strands of yarn are used for varied purposes. Some of them have been spun so fine as to be hardly noticeable to the naked eye. When two or more stretches are twisted together, they make thread or twine, and when interlaced, they make netting or cloth. The final product may be bleached, colored, or manipulated in various ways to produce effects pleasurable to the eye and suitable for peculiar purposes. The progress of civilization is not so well shown by comparison of final result as by comparison of the processes employed; for the ancient

tapestries and rugs show artistic effects beyond the province of the modern workman.

The distaff and the shuttle were known at least four thousand years ago. The spinning wheel is said to have been invented about three hundred and fifty years ago. The hand loom was a very primitive affair until the invention of the fly shuttle. The industry really began its rapid development with the introduction of steam power, although there seems to be no reason why water power could not have anticipated the use of steam. The first power machines used in textile manufacture were turned by treadmills driven by animals. A rough comparison to show the advance in hardly more than a century, would place the product of a modern cotton gin at 1000 to 1, as compared with a hand operative; the production of a modern spindle at 5000 to 1, as compared with a spinning wheel; and the product of a Northrop loom at least 100 to 1, as compared with the hand loom of the spinning wheel period. No civilized community could to-day produce the yarn and cloth which it consumes, with the old implements, if every man, woman and child worked on their production 24 hours each day; and in spite of the complication of the machinery employed, the cost of the machinery per product is less to-day than it was in the spinning wheel period.

Of the great textile industries in our country, that of cotton manufacture easily stands first. The machinery developed originally for cotton mills has been largely used without much modification in wool and silk manufacture as well. In cotton manufacture, cotton cloth represents the greater proportion of product; and of the cotton cloth, plain grades, such as prints, sheetings and shirtings, easily dominate.

In the pages following, we shall illustrate the machinery now used by the latest mills in producing the majority of the cotton yarn and cotton cloth manufactured in the United States. As the majority of the inventions that have developed these lines of cotton

machinery have been introduced by our concern and its predecessors, this catalogue really serves the general purpose of illustrating the progress of the industry as a whole, as well as the special purpose of interesting those immediately concerned in machine products.

STATISTICS OF COTTON MACHINERY INVENTIONS.

We give the following short table of important inventions as our own selection from various authorities. It possibly does injustice to some unknown or obscure inventors; but we have no knowledge of these earlier matters outside that obtained from contemporary records. The patent dates given from 1730 to 1790 are all for English inventions. From that date they are to be understood as American inventions, unless otherwise specified.

1730—First cotton yarn spun in England by machinery by Wyatt.

1733—English patent granted John Kay for the invention of the fly shuttle.

1738—Patent granted Lewis Paul for the spinning machinery supposed to have been invented by Wyatt.

1742—First mill for spinning cotton built at Birmingham; moved by asses; but not successful.

1748—Patent on a cylinder card as first used by hand, granted Lewis Paul.

1750—Fly shuttle in general use in England.

1756—Cotton velvets and quiltings first made in England.

1760—Stock cards first used for cotton by J. Hargrave. Drop box invented by Kay.

1762 / 1767 { Spinning-jenny invented by Hargrave.

1769—Arkwright obtains his first patent on spinning.

1774—Bill passed in England to prevent the export of cotton machinery.

1775—Second patent of Arkwright on carding, drawing and spinning.

1779 { Mule spinning invented by Crompton.
{ Peele's patent on carding, roving and spinning.

1782—Date of Watt's patent for the steam engine.

1783—Bounty granted in England for export on certain cotton goods.

1785—Power loom invented by Dr. Cartwright. Cylinder printing invented by Bell. A warp stop-motion described in Cartwright's patent.

1788—First cotton factory built in the United States at Beverly.

1789 { Sea Island cotton first planted in the United States.
{ Samuel Slater starts cotton machinery in New York.

1790—First cotton factory built in Rhode Island by Slater.

1792—First American loom patent granted to Kirk and Leslie.

1794—Cotton gin patented by Elias Whitney.

1801—Date given for invention of the Jacquard machine in France.

1803—Dressing machine and warper invented in England by Radcliffe, Ross and Johnson.

1804—First cotton mill built in New Hampshire, at New Ipswich.

1805—Power loom successfully introduced in England after many failures.

1806—First cotton mill built in Connecticut, at Pomfret.

1809—First cotton mill built in Maine, at Brunswick.

1812—First cotton mill built at Fall River.

1814—Cotton opener with lap attachment invented in England by Creighton.

1815—Power loom introduced into the United States at Waltham.

1816—*First loom temple of Ira Draper patented in the United States.

1818—Machinery for preparing sewing cotton invented in England by Holt.

1822—First cotton factory erected at Lowell.

1823 { Differential motion for roving frames patented by Arnold.
{ First export of raw cotton from Egypt to England.

1824—Tube frame or speeder patented by Danforth.

1825—Self-acting mule patented in England by Roberts.

1828 { Ring spinning patented by John Thorpe.
{ Cap spinning patented by Danforth.

1829—*Revolving loom temple improvements patented by Ira Draper.

1832—Stop-motion for drawing frames invented by Bachelder.

1833—Ring spinning frames first built by William Mason.

1834 { Weft fork patented in England by Ramsbottom and Hope.
{ Shuttle-changing loom by Reid and Johnson.

1840 — Automatic loom let-off of E. B. Bigelow invented about this time.
1840 — *Important temple improvement patented by George Draper.
1842—Weft fork perfected in England by James Bullough.
1846—*Parallel shuttle-motion patented by W. W. Dutcher.
1849—First cotton mill erected at Lawrence.
1850—*Date of Hayden's patent for railway-head evener.
1851—*Date of reciprocating temple patent of E. & W. W. Dutcher.
1853—Date of card-cleaning patent of G. Wellman.
1857—*Date of Snell & Bartlett's let-off patent.
1859 — Date of Cheetham shuttle-changing loom patent, the first American attempt in this direction.
1859 — *Date of Stearns' shuttle-motion patent.
1862 — *Date of Shepard's let-off patent.
1862 — *Date of card-guide patent of Hervey Kent.
1863—*Date of George Draper's loom stop-motion, used on every side dagger loom in the country.
1865—Date of Thomas Mayor's patent on roving frame improvements.
1866—*Date of first spindle patent, to J. E. Atwood.
1867 — *Date of Cottrell & Draper's double beam let-off patent.
1867 — *Date of important spindle patent granted Rabbeth & Atwood.
1868 — *Date of W. F. Draper's thin place preventer patent for looms.
1868 — *Date of first American self-threading shuttle patent of J. A. Metcalf.
1868 — *Date of patent of F. Haythorn, for the first spinning frame separator.
1869 — Date of important loom patent of Erastus B. Bigelow.
1869 — *Date of first bobbin-holder patent of A. M. Wade.
1869 — *Date of W. T. Carroll's double flange spinning ring patent.
1869 — *Date of first inside-catch shuttle patent, to J. H. Coburn.
1870 — *Date of patent on the original Walmsley warper stop-motion.
1870 — Date of Oliver Pearl's celebrated spindle patent.

* These devices all came under control of Hopedale interests at some period of their patent existence.

From this period the development of improvements in the cotton manufacturing industry is so closely associated with the now related detail of the business formerly done by the various firms and corporations represented by Draper Company, that we end our table with this last date, leaving the task of its amplification to posterity.

Passing to consideration of our own immediate affairs, the record may be briefly summarized as follows:

Our business, up to 1870, was largely devoted to the introduction of temples and other loom improvements. We had applied or sold the right to use our let-off motions on over 50,000 looms at the time. From the catalogues printed since 1870, the following list of important inventions introduced by Hopedale organizations may be taken:

The earlier devices included the Kent card-guide, the railway head evener, (on which royalty was paid by all the large outside cotton machinery manufacturers at the time), a line of patent bolsters and steps for spindles on spinning frames, fly frames and mules, the Hopedale warper, (which has always controlled the majority of sales in this line), the Carroll double adjustable spinning ring, and nearly all the parallel shuttle motions, let-off motions, and shuttle guides then in use. There was also a large and important business carried on in the introduction of the patent Thompson oil-can.

In 1872 we had commenced the introduction of the Sawyer spindle improvements and taken hold of the Damon cut marker.

In 1873 the Sawyer spindle was fairly started. The history of this invention, including its competition and victory over the Pearl, early Rabbeth, and other types, with its record of continuous litigation, includes the most interesting part of our business experience.

We had also by this time, started on the manufacture of spoolers.

By 1876 we were building twisters, a line in which we have always maintained a place in the front rank, and were using the Wade bobbin holder and Laflin Guide on our spoolers.

By 1881 we were changing from the Sawyer to the Rabbeth self-centering type of spindle, were introducing the evener for filling frames, inside catch shuttles, the Doyle separator, the Weeks banding machine, a new reel, and certain speeder improvements.

By 1887 we were introducing an improved roving frame, the Sherman and Whitin spindles, in addition to the Rabbeth style, the Clark balling machine, the Walcott warper, an entirely new twister and a line of automatic sprinklers.

By 1893 the celebrated 49D spindle had been our standard for some time.

By 1896 we had passed on to the Draper spindle, the Rhoades-Chandler separator, the cone-drive and other important warper improvements, the Straw chain-dyeing process, the Smith twister stop-motion and the Northrop loom. To-day we have important improvements in all the former lines, but no departure into new fields to any great extent. The sur-

prising growth of our loom business has limited attention to further new ventures.

The dates, as given, are those of our catalogues, rather than those of the exact dates at which the various machines mentioned were first sold. The importance of the various ideas is fully realized by the public, who have never failed to appreciate our improvements. In the lines of spinning, warping, spooling and plain weaving, we claim nearly all the really vital changes of the last thirty years. Some time ago it was figured that our changes in the spinning frame alone had made a profit of $50,000,000 to the cloth producer and consumer in this country through the introduction of some 8,000,000 Sawyer and Rabbeth spindles. As our total sales are now over 26,000,000, the same proportion would show a saving to date of over $162,500,000. It is interesting to note that the total price paid for these spindles is less than $26,000,000, a price which includes all the elements of cost and selling, leaving the possible profit a small fraction of the public gain.

We have always realized that a business founded on the introduction of patented improvements could only be successful by continual application, for patent protection is by no means continuous or secure. We keep a large force of inventors and draughtsmen busy over the betterment of our products, and for every novelty that is known by the trade, there are surely ten failures, each of which has usually consumed time and expense equal, at least, to that involved in the success. We have paid hundreds of thousands of dollars for inventions that have never proved valuable, have purchased hundreds of patents for no purpose but protection against the possible competitor, and made thousands of patterns for machinery that never left the works. All of these facts should be realized by the oft times, short sighted customer, who figures in his mind the possible profits we are deriving from some apparently high priced machine, without knowing the extent of the losses which have to be charged against the account.

The government allows purchasers of real estate to retain possession for unlimited periods, unless the same be required for certain public uses, in which case ample restitution is made. The man who writes a book may retain ownership by copyright for a period of some forty years. But the man who adds material benefit to civilization by evolving an improved means of accomplishing a desired end, is only allowed individual control for seventeen years; and it is doubtful if the average inventor is fortunate enough to receive profits from a profit-rendering idea during one-half of such a period. It has often been proposed to do away with patent protection entirely in view of its monopolistic features; but the opponents to the

system face a serious proposition when they consider cancelling the one open opportunity for the wage-earner to make a large profit out of his experience. Inventions result from accidental discovery, deductive reasoning, or intuitive perception. The accidents are naturally few; the reasoning of trained minds supply the greater part, and many of the most important inventions known to history were thus originated. The intuitive inventor is a rarer type, for he usually attacks a problem unhampered by precedent. There is plenty of evidence of the application of real genius in textile lines, as shown by the shuttle-motion of a loom, the drawing rolls of Arkwright, the jacquard-motion, the spinning-mule, the differential of the roving-frame, the high-speed spindle, and the Northrop loom.

Although the original inventor usually receives the greater part of public credit for the introduction of a novel principle, it may be fairly asserted that the difficulties of perfecting detail are often greater than those encountered in the making of the first operative mechanism, and the difficulties of introducing the idea after being perfected, both in principle and detail, are greater yet; for the general public is not progressive, but hidebound by tradition, convention, and habit. Kay was so persecuted for being a public benefactor that he had to leave England. The first power loom was destroyed by a mob, and mobs also ruined the first cards, and the first spinning machines that operated more than 20 spindles. The dressing machine kindled great opposition. Laborers have even resisted improvements that brought more healthful conditions, arguing that the short life of their own kind aided the unemployed. The more persistent and unfortunate opposition, however, comes from those who have large investments in standard machines, and dislike the necessity of replacement and the competition of those with better equipment.

In the earlier application of inventive talent to cotton machine processes, the irresponsible nature of certain patent claims aroused a feeling of concern among many manufacturers, who actually considered the question of organizing in order to protect their interests and improve their relations with patentees. It was then quite common for mills to buy the rights for patented inventions from people of no financial standing, and then be forced to pay royalty to some other party for the same invention, it being impossible to recover from the first claimant. Suits at law against mills were not uncommon, and the agent, or manager, was, of necessity, forced to qualify himself, more or less, as a patent expert. Although our former firm and its predecessors had been introducing patented improvements for many years, their personal actions were in no way responsible for this feeling, as up to

this time they had never brought suit, or been sued, on account of any patent or invention. Increasing responsibilities and enlargement of business, however, soon brought the necessity for legal action, and the outcome has been fortunate for all parties concerned. Continued success has developed a business in the introduction of patented improvements that is responsible enough to stand back of customers and guarantee them protection. **No manufacturer purchasing any of our improvements has ever paid a dollar to any other party for royalty on any of them, or to defend himself against claims of infringement.** By controlling the majority of new ideas in the lines of spinning, warping, spooling, twisting, and latterly, plain weaving, we relieve the mill of annoyance by standing between it and the inventor, as patentees bring their ideas to us instead of asking for trial at the mill. Our knowledge of the state of the art is usually sufficient to prevent wasting the mill's time on old ideas, and we have facilities for doing a great part of the necessary testing without troubling them. In case it is necessary to make a mill trial, we usually have found it possible to compensate for the annoyance in some way or other.

The public will probably never realize what has been saved to them by the concentration of these inventive lines. Without it there would be dozens of ideas brought to the attention of agents and treasurers, each claiming superiority, and the mills themselves would have to eventually bear the cost of experiments, and run the risk of vexatious litigation. With the possible adoption of various different styles of mechanism, there would be serious complication in the way of repairs and interchangeability. By concentrating capital and experience we are enabled to venture on tests and experiments that, under ordinary circumstances, would never have been tried. It has, of course, been impossible, for us to absolutely prevent our customers from being troubled by the solicitations of outsiders, whose ideas have not found favor with us, or who have started an attempt at competition, with the hope of either being bought out by us, or possibly happening on some chance to win a share of our profits. Where many bright men are working in the same line it is, of course, possible that many may hit somewhere near the mark at the same time. It is not practical, however, to attempt to make a commercial machine for each of the various ideas, as that would involve expensive complications. Those who are necessarily passed by, sometimes attempt an independent success; and competition of this nature is not at all times undesirable. That class, however, who give their time in palpable endeavor to evade patent claims, and produce a plausible imitation of some suc-

cessful device, are attempting to serve no practical purpose for the community at large. **We never yet started with the desire of making something just as good as that already known,** or something that might lessen the success of a deserving inventor. We have simply aimed to better the processes of cotton manufacture, trusting to public recognition to determine our compensation. **We believe that the efforts of our company and its predecessors have doubled the capacity of the operatives in the operations of spinning, spooling, warping, twisting, and plain weaving,** and we also believe this statement to be more conservative than the facts might warrant.

STATISTICS.

As this work is frankly intended to arouse interest in the further development of American cotton manufacture, it may be well to consider the past results, which prove the continued, unfaltering advance of this typically American industry. In collecting the figures tabulated, many perplexing differences were found, some of the statements in former literature being so out of proportion to the known facts that they were absolutely useless. Some of the tables printed in our former books have had to be revised in view of the discovery of better information. Any summary of this kind must be considered as more or less approximate.

	Capital Invested in Cotton Manufacturing in the United States.	Value of Products.	Number of Spindles.
1801			
1802			
1803			
1804			
1805			4,500
1806			
1807			8,000
1808			
1809			31,000
1810			87,000
1811			
1812			
1813			
1814			122,646
1815			130,000
1816			
1817			
1818			
1819			
1820			220,000
1821			230,000
1822			
1823			
1824			
1825			
1826			
1827			705,000
1828			
1829			
1830			
1831	$40,612,984	$32,000,000	1,246,703
1832			
1833			
1834			
1835			1,750,000
1836			
1837			
1838			
1839			
1840		$46,350,453	2,285,337
1841			
1842			
1843			
1844			
1845			
1846			2,500,000
1847			
1848			
1849			
1850	$74,500,934	$61,869,184	2,751,078

	Capital Invested in Cotton Manufacturing in the United States.	Value of Products.	Number of Spindles.
1851			
1852			
1853			
1854			
1855			
1856			
1857			
1858			
1859			
1860	$98,585,269	$115,681,774	5,235,727
1861			
1862			
1863			
1864			
1865			
1866			
1867			
1868			
1869	.....	.....	6,700,557
1870	$140,706,291	$177,489,739	7,132,415
1871			
1872			
1873			
1874	.....	.....	9,415,383
1875			
1876			
1877			
1878			
1879			
1880	$208,280,346	$192,090,110	10,635,435
1881	.....	.....	11,375,000
1882	.....	.....	12,150,000
1883	.....	.....	12,660,000
1884	.....	.....	13,300,000
1885	.....	.....	13,375,000
1886	.....	.....	13,400,000
1887	.....	.....	13,500,000
1888	.....	.....	13,550,000
1889	.....	.....	14,060,000
1890	$354,020,843	$267,981,724	14,405,000
1891	.....	.....	14,640,000
1892	.....	.....	15,200,000
1893	.....	.....	15,550,000
1894	.....	.....	15,700,000
1895	.....	.....	16,100,000
1896	.....	.....	16,650,000
1897	.....	.....	17,150,000
1898	.....	.....	17,450,000
1899	.....	.....	18,100,000
1900	$460,842,772	$332,806,156	20,000,000

COTTON MILL PRODUCTS, 1900.

ARRANGED IN ORDER OF YARDS WOVEN.

	Square Yards.	Rough Percentage.	Value.	Number of Looms.
Total	4,509,750,616	100	$243,218,155	450,682
Prints and converters' cloths	1,581,613,827	36	57,780,940	125,000*
Not finer than No. 28 warp	1,056,278,952		35,616,575	
Finer than No. 28 warp	525,334,875		22,164,365	
Sheetings and shirtings	1,212,403,048	27	55,513,032	100,000
Ginghams	278,392,708	6	16,179,200	25,000*
Napped fabrics	268,852,716	6	18,231,044	44,227*
Fancy woven fabrics	237,841,603	5	21,066,310	45,686
Drills	237,206,549	5	11,862,794	30,000*
Twills and satteens	235,860,518	5	14,301,302	28,839*
Ticks, denims and stripes	171,800,853	4	16,446,633	18,000*
Duck, total	129,234,076	3	14,263,008	15,000*
Duck, sail	11,750,151		2,216,371	
Duck, other	117,483,925		12,046,637	
Upholstery goods	50,334,609	1	8,670,384	5,000*
Mosquito and other netting	41,885,023	1	875,868	4,500*
Bags and bagging	30,039,616		2,554,192	4,421
Cottonades	26,323,947		2,791,431	2,500*
Corduroy, cotton, velvet and plush	7,961,523		2,682,017	800*
Yarns, sewing cotton, twine, tape and other products			89,588,001	1,709
Total value of all products, including above			332,806,156	

*Estimated. (The report only separates out the looms on certain lines.)

COMPARISON OF DIFFERENT TEXTILE INDUSTRIES IN 1900.

	Value of domestic products.	Exports.	Imports.	Total Consumption.
Cotton manufactures,	$339,200,320	$24,003,087	$39,789,989	$354,987,222
Wool manufactures,	296,990,484	1,300,362	15,620,487	311,310,609
Silk manufactures,	107,256,258	252,608	26,803,534	133,807,184
Totals,	$743,447,062	$25,556,057	$82,214,010	$800,105,015

The tables on the preceding page include cotton small wares in Cotton Manufactures. The United States is second in the Cotton Industry, third in Woolen and second in Silk.

COMPARISON OF CAPITAL INVESTED, ETC., IN DIFFERENT TEXTILE INDUSTRIES.

	Capital.	Wage Earners.
Cotton Manufactures	$460,842,772	297,929
Cotton small wares	6,397,385	4,932
Wool Manufactures	310,179,749	159,108
Silk Manufactures	81,082,201	65,416
Hosiery and knit goods	81,860,604	83,387
Flax, hemp and jute	41,991,762	20,903
Dyeing and finishing fabrics	60,643,104	29,776
Totals	$1,042,997,577	661,451

QUALITY AND QUANTITY OF YARN SPUN IN THE UNITED STATES.

	Average number of Cotton Yarn 1900.	Hanks of Yarn Spun.
Maine	22.937	1,536,000,000
New Hampshire	19.174	2,089,000,000
Vermont	27.894	151,000,000
Massachusetts	25.097	11,106,000,000
Rhode Island	36.541	2,822,000,000
Connecticut	30.373	1,360,000,000
New York,	23.457	985,000,000
New Jersey	35.370	432,000,000
Pennsylvania	16.489	555,000,000
Delaware	23.522	24,000,000
Maryland	9.357	281,000,000
Virginia	15.287	230,000,000
North Carolina	18.830	2,945,000,000
South Carolina	19.040	3,730,000,000
Georgia	14.371	1,680,000,000
Kentucky	13.722	124,000,000
Tennessee	12.722	141,000,000
Alabama	14.437	835,000,000
Mississippi	14.344	113,000,000
Arkansas	5.878	5,000,000
Louisiana	15.876	111,000,000
Texas	9.580	78,000,000
Western States	19.418	333,000,000
United States	21.573	31,660,000,000

NUMBER OF IMMIGRANTS OF FIRST TWELVE RACES ENTERING THE STATES MENTIONED FOR THE YEAR ENDING JUNE 30, 1904.

	Mass.	Georgia North Carolina South Carolina
English	5,935	90
Finnish	1,499	3
German	1,115	80
Greek	2,119	112
Hebrew	6,229	140
Irish	7,612	24
Italian	13,051	22
Lithuanian	1,604	
Polish	5,823	3
Portuguese	3,920	1
Scandinavian	3,978	20
Scotch	1,420	29
	54,305	524

The above figures may be of interest to those who are now facing the problem of attracting immigration to the cotton mill centers which are suffering from scarcity of help. At the period noted, the South had hardly begun any effort in this line and its future results should attract considerable attention.

COST OF PRODUCTION IN COTTON MILLS IN 1900 FOR EACH $100 WORTH OF PRODUCTS.

	Mass.	South Carolina.
Raw cotton	$40.68	$61.25
Other materials	15.85	9.58
Salaries	2.10	2.20
Wages	33.80	20.79
Miscellaneous expenses	7.57	6.18

These figures are obtained by taking the value of products in each state and reducing the known elements of value to a comparative basis. The goods of South Carolina, being coarser in fabric, contain more cotton and therefore the price of the cotton as an element of cost, is so large as to materially lessen the proportion of the other factors.

The salaries of South Carolina are evidently much larger as compared with the wages, and the miscellaneous expenses are also higher when figured with relation to the wages.

OTHER FIGURES OF INTEREST FROM STATISTICS OF 1900.

	Mass.	South Carolina.
Capital as reported at census	$135,873,779	$36,275,727
Capital stock	$71,088,500	$17,835,200
Pounds cotton used	517,088,846	229,899,760
Cost	$33,771,414	$14,909,520
Value of goods	$110,478,327.00	$29,723,919.00
Taxes per $1000 of value of land and property	17.11	7.57
Proportion of freight to $100 of material used	1.20	1.17
Spindles	7,784,687	1,431,349
Looms	179,280	42,663
Average number of yarn	25.097	19.04
Hanks of yarn spun	11,106,615,977	3,730,694,191
Production of brown or bleached sheetings and shirtings in square yards	176,283,924	283,105,383
Drills, twills and satteens	107,143,443	127,846,936
Plain cloths for printing or converting, not finer than No. 28 warp	687,235,050	77,848,108
Finer than No. 28 warp	240,170,139	97,343,526
Ginghams	53,932,358	16,752,808

Of the southern states South Carolina is ahead in production of plain cloths, twills and drills, but North Carolina is considerably ahead in fancy fabrics, ticks and denims, cottonades, napped fabrics and yarns, while Georgia is ahead in duck, bags and bagging.

These figures are all from the census of 1900 and may be relatively affected by the change of the last six years.

GENERAL FACTS OF PHYSICS.

Tenacity is proportioned to the area of the cross section.

A freely falling body traverses a distance of 16.08 feet the first second.

The distance traversed in any number of seconds is equal to 16.08 × number of seconds squared.

The length of a second pendulum is about 39 inches.

A horse power represents the ability to raise 33,000 pounds one foot high in one minute.

Water weighs about 62½ pounds to cubic foot.

The pressure of the atmosphere is about 15 pounds to the square inch.

SPINDLES IN USE.

Estimates of spindles in use during 1905 vary more or less. I give in two columns the high and low statistics obtained from various sources—in round figures.

	LOW	HIGH
Great Britain,	48,500,000	51,000,000
United States,	23,000,000	24,000,000
Germany,	8,800,000	8,830,000
Russia and Russian Poland,	7,000,000	7,800,000
France,	6,100,000	6,150,000
Austria and Hungary,	3,380,000	3,500,000
Spain,	2,600,000	2,900,000
Italy,	2,400,000	2,800,000
Switzerland,	1,600,000	1,710,000
Sweden and Norway,	450,000	460,000
Holland,	360,000	380,000
Portugal,	160,000	230,000
ONLY ONE ESTIMATE FOUND FOR THESE COUNTRIES.		
Belgium,	1,200,000	1,200,000
Greece,	70,000	70,000
Denmark,	60,000	60,000
Roumania,	40,000	40,000
Turkey,	80,000	80,000
Asia Minor,	60,000	60,000
India,	5,200,000	5,200,000
Japan,	1,330,000	1,330,000
China,	620,000	620,000
Canada,	770,000	770,000
Mexico,	630,000	630,000
Brazil,	450,000	450,000
	114,860,000	120,270,000

COMPARISON OF ESTIMATES OF COTTON CROP WITH ACTUAL PRODUCT REALIZED.

	December estimates of Department of Agriculture.	Crop Statements after close of season, by N. Y. Chronicle.
	BALES.	BALES.
Season of 1897–98	9,100,000	11,181,000
Season of 1898–99	10,000,000	11,235,000
Season of 1899–00	8,900,000	9,440,000
Season of 1900–01	10,100,000	10,425,000
Season of 1901–02	9,674,000	10,701,000
Season of 1902–03	10,417,000	10,758,000
Season of 1903–04	9,962,000	10,124,000
Season of 1904–05	12,168,000	13,557,000
Total,	80,321,000	87,421,000

The average under estimate is over 8 per cent.

The bale figures do not agree with our own table, as the actual bales are figured instead of statistical bales.

This table of print cloth statistics is made up for standard cloth 64 threads to the inch, 28 inches wide and made usually of No. 28 warp and No. 36 filling yarn. As now presented it differs somewhat in data and arrangement from former tables. The waste is now figured as **net** waste and the fifteen per cent. is fifteen per cent. of the cotton **bought.**

PRINT-CLOTH STATISTICS.

Year.	Highest Price of Print Cloth in Cents.	Lowest Price of Print Cloth in Cents.	Average Price. (Not Average of High and Low.)	Price per Lb. in Cents at 7 yds. per Lb.	Average Price of Middling Uplands per Lb. in Cents.	Probable Cost per Lb. of Cotton Used in Cents, with 15 per cent. Waste.	Margin Between Cotton and Cloth in Cents per Lb.
1860	5 3/4	4 7/8	5.44	38.08	11.	12.94	25.14
1861	9	4 1/4	5.33	37.31	13.01	15.31	22.
1862	14 1/2	7	9.81	68.67	31.29	36.81	31.86
1863	19	10 3/4	15.20	106.40	67.21	79.07	27.33
1864	38 1/2	16 1/4	23.42	163.94	101.50	119.41	44.53
1865	27 1/4	10	20.24	141.68	83.38	98.09	43.59
1866	19 1/2	11 1/4	14.13	98.91	43.20	50.82	48.09
1867	12	6 5/8	9.12	63.84	31.59	37.16	26.68
1868	9 5/8	6 1/2	8.18	57.26	24.85	29.24	28.02
1869	9 1/2	7 1/8	8.30	58.10	29.01	34.13	23.97
1870	8 1/4	6 1/2	7.14	49.98	23.98	28.21	21.77
1871	8	6 1/2	7.41	51.87	16.95	19.94	31.93
1872	9	7 3/8	7.88	55.16	22.19	26.11	29.05
1873	7 1/2	5 3/4	6.69	46.83	20.14	23.69	23.14
1874	6 1/2	5 1/4	5.57	38.99	17.95	21.11	17.88
1875	6 3/4	4 3/8	5.33	37.31	15.46	18.19	19.12
1876	4 7/8	3 3/8	4.10	28.70	12.98	15.27	13.43
1877	5 1/4	3 5/8	4.38	30.66	11.82	13.90	16.76
1878	4	3 1/4	3.44	24.08	11.22	13.20	10.88
1879	4 1/2	3 3/8	3.93	27.51	10.84	12.75	14.76
1880	5.87	3 3/4	4.51	31.57	11.51	13.54	18.03
1881	4 1/4	3 3/4	3.95	27.65	12.03	14.15	13.50
1882	3.95	3 5/8	3.76	26.32	11.56	13.60	12.72
1883	3 1/8	3.44	3.60	25.20	11.88	13.98	11.22
1884	3.62	3.08	3.36	23.52	10.88	12.80	10.72
1885	3 1/4	2.98	3.12	21.84	10.45	12.29	9.55
1886	3 1/2	3 1/4	3.31	23.17	9.28	10.91	12.26
1887	3 5/8	3 1/4	3.33	23.31	10.21	12.01	11.30
1888	4	3 1/2	3.81	26.67	10.03	11.80	14.87
1889	4 1/16	3 1/2	3.81	26.67	10.65	12.52	14.15
1890	3 7/16	3	3.34	23.38	11.07	13.02	10.36
1891	3 1/16	2 3/4	2.95	20.65	8.60	10.11	10.54
1892	4 1/16	3 1/16	3.39	23.73	7.71	9.07	14.66
1893	4	2 3/4	3.30	23.10	8.56	10.07	13.03
1894	3	2 1/2	2.75	19.25	6.94	8.16	11.09
1895	3 5/16	2 7/16	2.86	20.02	7.44	8.75	11.27
1896	3	2 7/16	2.60	18.20	7.93	9.33	8.87
1897	2 11/16	2 1/4	2.48	17.36	7.	8.24	9.12
1898	2 7/8	1 7/8	2.06	14.42	5.94	6.99	7.43
1899	3 1/4	2 3/8	2.69	18.83	6.88	8.09	10.74
1900	3 1/2	2 3/4	3.21	22.47	9.25	10.88	11.59
1901	3 1/2	2 3/4	2.84	19.88	8.75	10.29	9.59
1902	3 3/4	3	3.11	21.77	9.	10.59	11.18
1903	3 3/4	3	3.25	22.75	11.18	13.15	9.60
1904	4	3	3.44	24.08	11.75	13.82	10.26
1905	3 3/4	2 5/8	3.12	21.84	9.80	11.53	10.31
1906							
1907							
1908							
1909							
1910							

Cotton Crop of the United States Expressed in Statistical Bales of 500 Pounds Net Weight.

Year.	Crop in thousands of bales.	Average Price in Cents.	Year.	Crop in thousands of bales.	Average Price in Cents.
1788-89	2,000		1851-52	2,676,000	12.14
1789-90	3,000	14.5	1852-53	2,993,000	9.5
1790-91	4,000	26.	1853-54	2,643,000	11.02
1791-92	6,000	26.	1854-55	2,588,000	10.97
1792-93	10,000	29.	1855-56	3,069,000	10.39
1793-94	16,000	32.	1856-57	2,746,000	10.30
1794-95	16,000	33.	1857-58	2,879,000	13.51
1795-96	20,000	36.5	1858-59	3,592,000	12.23
1796-97	22,000	36.5	1859-60	4,582,000	12.08
1797-98	30,000	34.	1860-61	3,672,000	11.
1798-99	40,000	39.	1861-62	4,293,000	13.01
1799-00	70,000	44.	1862-63	1,526,000	31.29
1800-01	96,000	28.	1863-64	429,000	67.21
1801-02	110,000	44.	1864-65	286,000	101.50
1802-03	120,000	19.	1865-66	2,000,000	83.38
1803-04	130,000	19.	1866-67	2,062,000	43.20
1804-05	140,000	20.	1867-68	2,242,000	31.59
1805-06	160,000	23.	1868-69	2,101,000	24.85
1806-07	160,000	22.	1869-70	2,703,000	29.01
1807-08	150,000	21.5	1870-71	3,830,000	23.98
1808-09	164,000	19.	1871-72	2,641,000	16.95
1809-10	170,000	16.	1872-73	3,510,000	22.19
1810-11	160,000	16.	1873-74	3,634,000	20.14
1811-12	150,000	15.5	1874-75	3,393,000	17.95
1812-13	150,000	10.5	1875-76	4,122,000	15.46
1813-14	140,000	12.	1876-77	3,971,000	12.98
1814-15	200,000	15.	1877-78	4,282,000	11.82
1815-16	248,000	21.	1878-79	4,556,000	11.22
1816-17	260,000	29.5	1879-80	5,412,000	10.84
1817-18	250,000	26.5	1880-81	6,062,000	11.51
1818-19	334,000	34.	1881-82	4,904,000	12.03
1819-20	320,000	24.	1882-83	6,452,000	11.56
1820-21	360,000	17.	1883-84	5,225,000	11.88
1821-22	420,000	16.	1884-85	5,198,000	10.88
1822-23	370,000	16.5	1885-86	6,030,000	10.45
1823-24	430,000	11.	1886-87	5,977,000	9.28
1824-25	510,000	15.	1887-88	6,516,000	10.21
1825-26	700,000	21.	1888-89	6,736,000	10.03
1826-27	540,000	11.	1889-90	6,888,000	10.65
1827-28	650,000	9.5	1890-91	8,242,000	11.07
1828-29	730,000	10.25	1891-92	8,526,000	8.60
1829-30	700,000	10.	1892-93	6,318,000	7.71
1830-31	770,000	10.	1893-94	7,115,000	8.56
1831-32	780,000	9.25	1894-95	9,480,000	6.94
1832-33	890,000	10.	1895-96	6,798,000	7.44
1833-34	920,000	11.	1896-97	8,281,000	7.93
1834-35	921,000	13.	1897-98	10,775,000	7.
1835-36	1,014,000	16.5	1898-99	10,940,000	5.94
1836-37	1,078,000	13.25	1899-00	8,997,000	6.88
1837-38	1,365,000	10.14	1900-01	9,991,000	9.25
1838-39	1,045,000	13.36	1901-02	10,344,000	8.75
1839-40	1,668,000	8.92	1902-03	10,274,000	9.
1840-41	1,288,000	9.50	1903-04	9,682,000	11.18
1841-42	1,337,000	7.85	1904-05	13,436,000	11.75
1842-43	1,945,000	7.25	1905-06		9.80
1843-44	1,692,000	7.73	1906-07		
1844-45	1,987 000	5.63	1907-08		
1845-46	1,726,000	7.87	1908-09		
1846-47	1,513,000	11.21			
1847-48	2,034,000	8.03			
1848-49	2,499,000	7.55			
1849-50	2,000,000	11.			
1850-51	2,041,000	12.34			

Read price column with reference to first column of year figures. Prices given are for calendar year.

COTTON CROP.

The cotton plant is mainly grown in the United States, India, Egypt, China, Brazil and Asiatic Russia. The cotton crop of the United States is the most important and the most useful, its price practically controlling that of other cottons. The Sea Island and Egyptian cottons have the longer staple, while the Chinese and Indian varieties are very short in staple. These latter cottons are practically consumed in the countries in which they are raised.

In the cotton crop statistics, as given, various sources of figures have been consulted, and no one source accepted throughout. Not knowing the different methods of computatation employed by different parties, it is impossible to combine with accuracy; yet, the table given should be sufficient for practical purposes. The figures from 1870, on, are copied by courtesy of Colonel A. B. Shepperson, from various editions of his "Cotton Facts" and refer to the "Commercial" crop. The prices from 1821, on, are understood to be for Middling Upland cotton in New York. Read this column with relation to **first** column of yearly figures.

Tables are sometimes given for the crop in earlier years, where the commercial bale weighed but 250 pounds. Modern statistics are figured with the bale at 500 pounds net, so that the term "bale" by no means conveys an unchanging meaning. It is necessary to standardize on some unit, for the weight of bales varies with different seasons, showing a tendency to increase each year. Thus, the net weights which average 420 pounds in the season of '55-'56, reached an average of 484 pounds in the season '94-'95. Gross weights have run as high as 530 pounds in certain states, for an average season. Egyptian bales are compressed into a size somewhat similar to the American bale, but the average weight is usually over 700 pounds. The Indian bales, on the contrary, which are also more closely compressed than the American, usually weigh about 400 pounds. The Eyptian bale is packed to a density of 45 pounds to the cubic foot, against perhaps 22 pounds for the ordinary American bale.

Grades of cotton:

Ordinary.	Middling.
Strict ordinary.	Strict middling.
Good ordinary.	Good middling.
Strict good ordinary.	Strict good middling.
Low middling.	Middling fair.
Strict low middling.	Fair.

Cotton is purchased by most manufacturers in the shape of a bale. Small Southern mills in cotton raising sections can have their cotton delivered by team direct from the gin, without going through the compress. In this way they save cost and the greater part of the transportation expense. They also save in the strength of the cotton fibre itself, providing that the process of compression injures the fibre. This, in our mind, is only a theoretical advantage. There is no doubt, however, but that they get better cotton, being nearer the source of supply and having better opportunities for selection. The process of baling should receive enough attention by interested parties to ensure a much more satisfactory trade bundle than formerly. However the cotton is finally delivered, it must be ginned first.

As to the process of ginning, it is supposed to separate the fibre from the seed and leaf. We say it is *supposed* to do so, because the cotton bale proves that the process is not at all satisfactory. We think the machines are probably overcrowded or speeded too high. Discussion is continuous regarding the merits of the roller gin versus the saw gin. The saw gin is said to mangle and tear the fibre in a way which the roller gin may prevent. There is no doubt but there is great chance here for invention, which will gin cotton in such a way as to thoroughly remove all foreign substances without harmful injury to the staple.

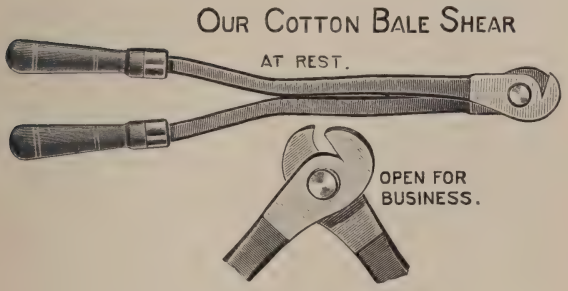
While the seed, dirt and leaf, which form nearly a tenth of the weight of the usual bale, can be extracted in the mill at the picker and card, it is not equitable to have to pay for them at cotton prices.

When cotton arrives at the mill in the shape of a bale, it is found necessary to cut ties and loosen up the cotton before use. This may be done in two ways. One method being to pull the bale apart by hand, and the other to pass it through a bale breaker or similar machine, which loosens up the cotton by means of beaters. The hand method is probably less liable to damage the cotton, but the question of expense may favor mechanical means. Some of the round bales require special treatment.

When the cotton arrives at the mill it starts on a continuous journey through successive machines. In spite of the fact that such machine process is believed to tear and weaken the fibre more or less, we find that the higher grades of yarn and cloth demand the greater number of machine methods. The question as to the proper selection of machinery introduces chance for the gravest error. An old mill management should have experience enough to guide them, but a new mill may easily err. Whenever a mill is built by capitalists who have

had little experience in cotton manufacturing, it is usually wise to adopt suggestions of a competent mill engineer.

In cotton machinery, as well as other trades, there are well known specialists. It is possible to buy an entire mill equipment from single concerns, but we should hesitate in advising such a course. The field is too broad for any one concern to monopolize the best products of every class. Realizing this we have personally devoted our energies to a few special machines and are confident that we excel in those lines.



OUR COTTON BALE SHEAR.

We have supplied the trade with shears of various patterns for many years. Our present device has given universal satisfaction wherever used, and we have sold many hundred pairs.

A device of this kind depends fully as much on workmanship and material as on design. We have never heard of any case where our present shears failed to give perfect satisfaction and a purchaser may be assured in advance that he is not trying an experiment. There is no need of argument against the old custom of cutting ties with a dull axe as the insurance people have condemned that for us. The question of expense need not stand in the way as the price is but $10 per pair.

Specify in ordering whether the ties to be cut are on American or Egyptian bales. The Egyptian bale having a wider tie, requires a different pattern of shear; a mill using both kinds of cotton, can use the Egyptian shear for both bales.

OPENING AND PICKING.

In arranging the picker room, care must be taken for precautions against fire, as the action of the swiftly revolving beaters is very apt to make sparks, providing any metal substance should be fed in with the cotton. Hot bearings can also make trouble, as there are many swiftly revolving shafts.

The picking machinery is the heaviest used in the ordinary manufacture of cotton into cloth, and great care must be exercised in setting it up and properly leveling the parts. All revolving shafts should run without cramping, and the beaters should be nicely balanced. It is not necessary to specify details, as only the usual mechanical skill is necessary. Unfortunately, all men who handle machinery are not mechanics in the proper meaning of the word. A little careful oversight, therefore, will do no harm.

Great improvement has been made in picking machinery in late years. Without going into the various rival processes, it can be stated as a general axiom that the method which cleans the cotton with the least mechanical action is probably the best.

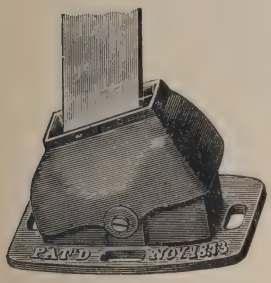
The use of good modern feeders in the pickers' room will help more toward a thorough opening up and mixing of the fibre than any other single improvement. It will also tend to prevent crowding and make more even laps.

It is of course essential that an even lap be produced. A good clean lap cannot be made on any machine that is crowded, as there is not time or opportunity for dirt and leaf to separate from the fibre. Dirt should be removed from under the beaters with regularity, and cleanliness in this department should be regarded as a virtue of the highest order. Oiling should be attended to by a competent hand, as this machinery is more than usually liable to trouble from dry or hot bearings.

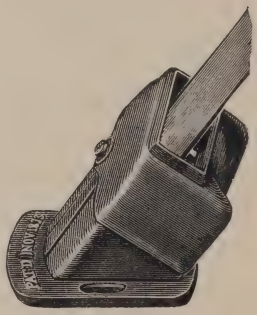
The overseer of this room should be a good manager, and should keep his accumulations of laps regular and not excessive. If the weight is irregular, the laps having the greatest variation should be run through again. Picking machinery uses a great deal of air in the various fans, and we have always advised that this air be taken from the interior of the mill itself, rather than from the outside. We see no reason for changing our opinion.

WOOD'S BELT HOLE GUARDS.

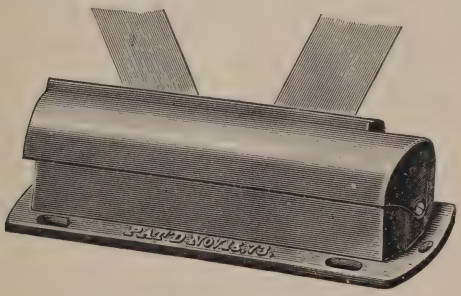
We have introduced thousands of the Belt Hole Guards, originally patented by Mr. B. L. Wood, and can furnish the best article of the kind ever made. Our patterns are varied to meet the requirements, and have no joints or edges to wear the belt.



FOR STRAIGHT BELTS.



FOR BEVELED BELTS.



FOR CROSSED BELTS.

Wood's Belt Hole Guards are desirable for the following reasons:

1st. By the rotary movement of the covers the belt hole is much reduced in size, at least three-quarters in cross belt holes. To illustrate, a two-inch cross belt requires a hole about four inches wide by its spread, say six to ten inches in length. These guards reduce the hole to about three-fourths of an inch

in width by about nine to ten inches in length, being a reduction in the size of the hole from thirty-two square inches to only six.

2d. The floor may be flooded, in case of fire, to the depth of two inches with no danger of the water running through the belt holes and injuring goods and machinery in the rooms below.

3d. In case of fire these guards prevent the flames from passing through the belt holes, either up or down, and are of the utmost importance in this particular.

4th. They prevent dirt, cotton, threads, waste, spools and other articles from passing through the belt holes into the lights, or the cards, or other machinery below.

5th. There is always a great quantity of imperceptible dust passing through the belt holes, following the current of air caused by the motion of the belt. These guards prevent them to a great extent.

6th. They very largely prevent the heat from passing from the lower to the upper room.

7th. They never require to be oiled and will never clog up and stick.

8th. They prevent any twisting of the belt.

9th. The movement of the cover is so easy that there is no material friction or wear of the belt, it requiring but a slight touch of the belt as it moves from one pulley to another to carry the cover with it.

10th. The movable top keeps the belt square on the pulley and prevents it from running part on the tight pulley and part on the loose pulley, as is often the case.

11th. They are highly recommended by Insurance Companies.

We like to trade with mills that think the best is none too good for them. An order for these Guards will place yours in that category.

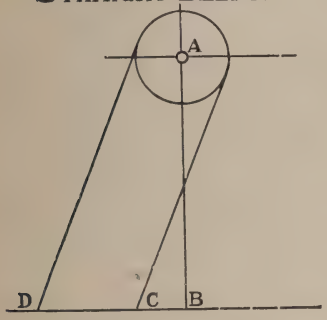
DIRECTIONS FOR ORDERING.

If care is used in following these directions, much trouble will be saved. Reference to the accompanying diagrams will make the matter plain.

Ordered by.....

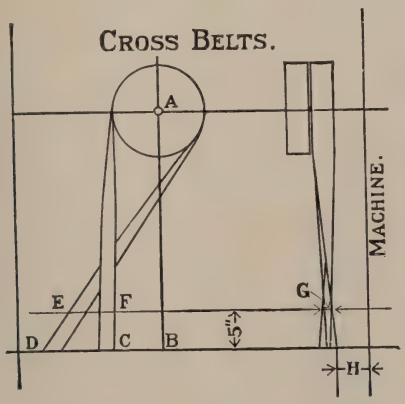
Date.....190.....

FOR STRAIGHT BELTS—ANSWER THE FOLLOWING QUESTIONS:



No. of machines guards are required for.....
Width of Belt.....
Diameter of Pulley.....
Distance A to B.....
Distance B to C.....
Distance B to D .....
Distance C to D.....
Distance Belt is from machine when on pulley next to machine.....

FOR CROSSED BELTS—ANSWER THE FOLLOWING QUESTIONS:

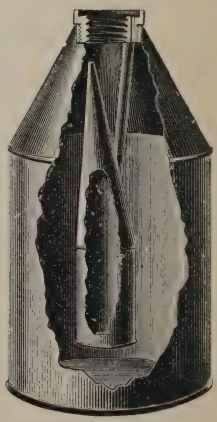


Number of machines guards are required for.....
Width of Belt.....
Distance A to B.....
Diameter of pulley .....
Distance B to C.....
Distance B to D.....
Distance C to D.....
Distance F to E, (5 in. above floor.).....
Distance H, when belt is on pulley next to machine.....
Distance G, (5 in. above floor.).....

GETCHELL'S IMPROVED THOMPSON OIL-CAN.

We have been intimately connected with the manufacture of oil-cans for over 40 years.

During the term of the Thompson patent we manufactured an oil-can that was not equalled for economy, convenience and durability; and in introducing the improvement of a removable air-chamber and vent-tube with a case-hardened delivery-tube, we have made the Getchell Improved Thompson Can superior to all others that we have any knowledge of. No other oil-can has been sold in such quantities as the Thompson of our make.



GETCHELL'S OIL-CANS.

We stamp every can and guarantee it to be perfect.

Before concluding that a cheaper can is as good as ours, we ask for a trial in connection with any other in the market, feeling confident that our cans have no equal for economy in the use of oil, neatness and durability.

DIRECTIONS FOR ORDERING GETCHELL'S IMPROVED THOMPSON OIL-CANS.

Large	. .	3¼	in. high,	2¾	in. diam.,	holding	3	gills.
Common	.	3	" "	2½	" "	"	2	"
Small	. .	2⅜	" "	2⅛	" "	"	1	"

We distinguish the tubes by the size of the holes: That is, No. 19 has a hole No. 19 wire gauge; No. 20 has a hole No. 20 wire gauge. Those most frequently wanted are Nos. 19, 20 and 21; but we make tubes with any size of hole to order.

Our common length of tube is 3¼ inches. Tubes of greater length we make to order.

Send for sample lot of cans.

A proper system of oiling will make a heavy cut in the repair bill. The better the oil-can, the better the chance of intelligent use.

CARDING.

The card room, as now constituted, contains revolving flat cards, drawing frames, and coarse and fine roving frames. Many mills also still use the railway head and lap winder, and combing machines are becoming quite a common factor.

This room is arranged under the usual mill plan; an overseer and second hand being required to supervise the help. It has been found advisable in the arrangement of mills to have a different overseer over each department, so that each one can criticise the others' product and keep him up to the mark.

As in other departments of a mill, crowding should not be allowed in any event. The machinery is designed for certain speeds and productions, and no machine bears over production so badly as a card. The clothing is apt to be seriously damaged, and the product affects all the subsequent machinery.

All the machinery in the carding room must be substantially set in place and accurately leveled. The floor under the machinery should be protected with galvanized iron having upturned edges. The cards require special attention in setting up and application of the card clothing. While there are many kinds of card clothing in use, there is probably little question as to which are the better grades. It is poor economy to use any other.

Cards should be properly ground before use. Plenty of time should be taken, and this job should be carefully supervised. The more accurately the card is made mechanically, the less will be the necessity for grinding, as it is in this first grinding that all inequalities must be removed.

In setting up and starting roving-frames, see that all parts are level and in line, and firmly fixed where they belong; rub the steel rolls lengthwise with whiting and oil, on a piece of card clothing. This will take off all the sharp edges and make them run much better. Oil the shells and all roll bearings and wipe off all dirty oil. Run some time before putting work into them. Look out for hot bearings; they damage the machine and are very liable to set loose cotton on fire. Each spindle and flyer wants the same attention in starting that it would have if there were but one to be run instead of thousands. If anything is found broken or damaged so that it will not fill its requirements properly, it should not be tinkered, but thoroughly made good without delay. Careful attention to the covering of the top-rolls will detect any uneven places and save trouble later.

Great attention has been given in late years to providing a proper temperature and moisture in the various parts of the mill; not only for the benefit of the cotton processes, but also for the benefit of the help in hot weather. We do not care to specify any particular plan, but certainly recommend that some efficient means be employed for this purpose.

CARD CLOTHING.

English Counts.	Points per Square Foot.	American No. of Wire.
60s	43,200	28
70s	50,400	30
80s	57,600	31
90s	64,800	32
100s	72,000	33
110s	79,200	34
120s	86,400	35
130s	93,600	36

The tables which follow for numbering roving have been extended and adapted for numbering from weights in tenths of grains. Twist in all cases is 1.20 times the square root of the number.

In the earlier editions of our catalogues, we grouped the various departments in turn, illustrating our machinery for each process, and following up with rules and tables. In view of the time and trouble for re-arrangement of each edition on this plan, we shall now group all our standard matter together so that changes in the latter portion of the book can be more easily made in following editions.

RULES FOR CARDERS.

To determine the number of hanks or decimal parts of hanks to the pound for carding, drawing, slubbing, roving and yarn, according to a given number of yards reeled or measured:—

Multiply the number of yards by $8\frac{1}{3}$ and divide by their weight in grains; the quotient will be the hanks or decimal parts of hanks required.

One yard of No. 1 roving or yarn weighs $8\frac{1}{3}$ grains.

To ascertain what number of yarn will be produced from a given drawing or sliver:—

Measure off a convenient number of yards of sliver, multiply this number by extent of drawing on roving and spinning heads, then multiply by $8\frac{1}{3}$ and divide by the weight in grains, which will give the number of yarn produced from the given sliver. *Example:* Take two yards of sliver weighing 20 grains, and suppose it is to be drawn 5 on roving and 10 on spinning.

$2\times5\times10\times8\frac{1}{3}=833.3,\div20=$No. 41.6, the number of yarn.

To determine what weight a given length of drawing, slubbing, roving or yarn should be to equal a given number of hanks or decimal parts of hanks:—

Multiply the given number of yards in length by $8\frac{1}{3}$ and divide by the number of hanks or decimal parts of hanks required; the quotient will be the weight, in grains, of the given length of drawing, roving or yarn.

To number the yarn produced from roving:—

Reel or measure off a convenient number of yards of roving; multiply this number by extent of drawing on spinning heads. This product multiplied by $8\frac{1}{3}$ and divided by the weight, will give the number of yarn which would be made from the roving. *Example:* Suppose 5 yards of roving weigh 20 grains, and the draught is 10. Then $5\times10\times8\frac{1}{3}=416.6,\div20=$ 20.8, the number of the yarn.

Given, the weight of lap from the picker, and draught and doublings from the card to the spinning frame: To find the weight at any given point and number of yarn that will be produced:—

Example: Weight of lap, 9 oz.; single carding, draught, 100; railway head, draught, 4; doublings, 14; first drawing, draught, 4, doublings, 3; second drawing, draught, $4\frac{1}{2}$, doublings, 3; slubbers, draught, 4; intermediates, doublings, 2, draught, $5\frac{1}{2}$; fine frames, doublings, 2, draught, $6\frac{1}{2}$; spinning frames, draught, $7\frac{1}{2}$; allowance for flyings and strippings in carding, 12 per cent.; allowance for take up by twist in slubbing, intermediate, fine and spinning frames, $\frac{1}{31}$ each, or about $\frac{1}{2}$ in all; with the following result:—

$9\times437.5=3937.5$ grains in 1 yard of lap.

$3937.5\div100=39.375$ grains in 1 yard after leaving card, were there no loss.

$39.375\times.88=34.65$ grains in 1 yard after deducting 12 per cent. for flyings and strippings.

$34.65\times14\div4=121.27$ grains in 1 yard after leaving railway head.

$121.27\times3\div4=90.95$ grains in 1 yard after leaving first drawing.

$90.95\times3\div4\frac{1}{2}=60.63$ grains in 1 yard after leaving second drawing.

$60.63\div4\times\frac{32}{1}\times12=187.76$ grains in 12 yards after leaving slubbers.

$187.76\times2\div5\frac{1}{2}\times\frac{32}{31}=70.48$ grains in 12 yards after leaving intermediates.

$70.48\times2\div6\frac{1}{2}\times\frac{32}{31}=22.39$ grains in 12 yards after leaving fine frames.

$22.39\div7\frac{1}{2}\times\frac{32}{31}=3.081$ grains in 12 yards after leaving spinning frames.

$3.081\times70=215.67$ grains in 1 hank after leaving spinning frames.

$7000\div215.67=32.45$ number of yarn.

Rule: Multiply the weight in ounces of one yard of lap by 437.5 (grains in an avoirdupois ounce), to reduce to grains; divide by draught of card and multiply by $\frac{88}{100}$ to give weight with allowance for loss in carding; for each successive process, multiply by the doublings and divide by the draught, and on slubbing, intermediate, fine and spinning frames multiply

by $\frac{32}{31}$ to allow for increase in weight by twist; at slubbers multiply by 12 for a common number of yards to weigh; and at spinning frames by 70, to give weight per hank, and divide 7000 by the product to determine the number of yarn.

NOTE.—Roving and yarn contract in twisting, and an allowance should be made for this in all computations for a twisted product. This allowance will vary with the number of the yarn and amount of twist put in.

To find the weight of lap required to produce a given number of yarn, and also the weight at any given point, the draught and doublings being known:—

Example: Suppose the draught and doublings the same as in the preceding, and we wish to produce No. 32.45 yarn.

7000÷32.45=215.71 grains per hank.

215.71÷70=3.081 grains per 12 yards.

3.081×$\frac{31}{32}$×7$\frac{1}{2}$=22.39 grains per 12 yards after leaving fine frames.

22.39×$\frac{31}{32}$×6$\frac{1}{4}$÷2=70.49 grains per 12 yards after leaving intermediates.

70.49×$\frac{31}{32}$×5$\frac{1}{2}$÷2=187.78 grains per 12 yards after leaving slubbers.

187.78×$\frac{31}{32}$×4÷12=60.63 grains per 1 yard after leaving second drawing.

60.63×4$\frac{1}{2}$÷3=90.95 grains per 1 yard after leaving first drawing.

90.95×4÷3=121.27 grains per 1 yard after leaving railway-head.

121.27×4÷14=34.65 grains per 1 yard after leaving card.

34.65×100×$\frac{100}{88}$=3937.5 grains per 1 yard of lap.

3937.5÷437.5=9 ounces per 1 yard of lap.

Rule: Divide 7000 by the number of yarn desired, and that quotient by 70 to give the weight of 12 yards; multiply by the draught of each machine and divide by the doublings; for spinning, fine, intermediate and slubbing frames multiply by $\frac{31}{32}$ to allow for decrease in weight by taking out the twist; at second drawing divide by 12 to give the weight of one yard; multiply by $\frac{100}{88}$ at the card to allow for loss, and divide by 437.5 to give weight of lap required in ounces.

TABLE FOR NUMBERING ROVING.

12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.
1.	100.00	**9.**	11.11	**16.**	6.25	**23.**	4.35	**30.**	3.33
.2	83.33	.1	10.99	.1	6.21	.1	4.33	.1	3.32
.4	71.43	.2	10.87	.2	6.17	.2	4.31	.2	3.31
.6	62.50	.3	10.75	.3	6.13	.3	4.29	.3	3.30
.8	55.56	.4	10.64	.4	6.10	.4	4.27	.4	3.29
2.	50.00	.5	10.53	.5	6.06	.5	4.26	.5	3.28
.2	45.45	.6	10.42	.6	6.02	.6	4.24	.6	3.27
.4	41.67	.7	10.31	.7	5.99	.7	4.22	.7	3.26
.6	38.46	.8	10.20	.8	5.95	.8	4.20	.8	3.25
.8	35.71	.9	10.10	.9	5.92	.9	4.18	.9	3.24
3.	33.33	**10.**	10.00	**17.**	5.88	**24.**	4.17	**31**	3.23
.1	32.26	.1	9.90	.1	5.85	.1	4.15	.1	3.22
.2	31.25	.2	9.80	.2	5.81	.2	4.13	.2	3.21
.3	30.30	.3	9.71	.3	5.78	.3	4.12	.3	3.19
.4	29.41	.4	9.62	.4	5.75	.4	4.10	.4	3.18
.5	28.57	.5	9.52	.5	5.71	.5	4.08	.5	3.17
.6	27.78	.6	9.43	.6	5.68	.6	4.07	.6	3.16
.7	27.03	.7	9.35	.7	5.65	.7	4.05	.7	3.15
.8	26.32	.8	9.26	.8	5.62	.8	4.03	.8	3.14
.9	25.64	.9	9.17	.9	5.59	.9	4.02	.9	3.13
4.	25.00	**11.**	9.09	**18.**	5.56	**25.**	4.00	**32.**	3.12
.1	24.39	.1	9.01	.1	5.52	.1	3.98	.1	3.12
.2	23.81	.2	8.93	.2	5.49	.2	3.97	.2	3.11
.3	23.26	.3	8.85	.3	5.46	.3	3.95	.3	3.10
.4	22.73	.4	8.77	.4	5.43	.4	3.94	.4	3.09
.5	22.22	.5	8.70	.5	5.41	.5	3.92	.5	3.08
.6	21.74	.6	8.62	.6	5.38	.6	3.91	.6	3.07
.7	21.28	.7	8.55	.7	5.35	.7	3.89	.7	3.06
.8	20.83	.8	8.47	.8	5.32	.8	3.88	.8	3.05
.9	20.41	.9	8.40	.9	5.29	.9	3.86	.9	3.04
5.	20.00	**12.**	8.33	**19.**	5.26	**26.**	3.85	**33.**	3.03
.1	19.61	.1	8.26	.1	5.24	.1	3.83	.1	3.02
.2	19.23	.2	8.20	.2	5.21	.2	3.82	.2	3.01
.3	18.87	.3	8.13	.3	5.18	.3	3.80	.3	3.00
.4	18.52	.4	8.06	.4	5.15	.4	3.79	.4	2.99
.5	18.18	.5	8.00	.5	5.13	.5	3.77	.5	2.99
.6	17.86	.6	7.94	.6	5.10	.6	3.76	.6	2.98
.7	17.54	.7	7.87	.7	5.08	.7	3.75	.7	2.97
.8	17.24	.8	7.81	.8	5.05	.8	3.73	.8	2.96
.9	16.95	.9	7.75	.9	5.03	.9	3.72	.9	2.95
6.	16.67	**13.**	7.69	**20.**	5.00	**27.**	3.70	**34.**	2.94
.1	16.39	.1	7.63	.1	4.98	.1	3.69	.1	2.93
.2	16.13	.2	7.58	.2	4.95	.2	3.68	.2	2.92
.3	15.87	.3	7.52	.3	4.93	.3	3.66	.3	2.92
.4	15.62	.4	7.46	.4	4.90	.4	3.65	.4	2.91
.5	15.38	.5	7.41	.5	4.88	.5	3.64	.5	2.90
.6	15.15	.6	7.35	.6	4.85	.6	3.62	.6	2.89
.7	14.93	.7	7.30	.7	4.83	.7	3.61	.7	2.88
.8	14.71	.8	7.25	.8	4.81	.8	3.60	.8	2.87
.9	14.49	.9	7.19	.9	4.78	.9	3.58	.9	2.87
7.	14.29	**14.**	7.14	**21.**	4.76	**28.**	3.57	**35.**	2.86
.1	14.08	.1	7.09	.1	4.74	.1	3.56	.1	2.85
.2	13.89	.2	7.04	.2	4.72	.2	3.55	.2	2.84
.3	13.70	.3	6.99	.3	4.69	.3	3.53	.3	2.83
.4	13.51	.4	6.94	.4	4.67	.4	3.52	.4	2.82
.5	13.33	.5	6.90	.5	4.65	.5	3.51	.5	2.82
.6	13.16	.6	6.85	.6	4.63	.6	3.50	.6	2.81
.7	12.99	.7	6.80	.7	4.61	.7	3.49	.7	2.80
.8	12.82	.8	6.76	.8	4.59	.8	3.47	.8	2.79
.9	12.66	.9	6.71	.9	4.57	.9	3.46	.9	2.79
8.	12.50	**15.**	6.67	**22.**	4.55	**29.**	3.45	**36.**	2.78
.1	12.35	.1	6.62	.1	4.52	.1	3.44	.1	2.77
.2	12.20	.2	6.58	.2	4.50	.2	3.42	.2	2.76
.3	12.05	.3	6.54	.3	4.48	.3	3.41	.3	2.75
.4	11.90	.4	6.49	.4	4.46	.4	3.40	.4	2.75
.5	11.76	.5	6.45	.5	4.44	.5	3.39	.5	2.74
.6	11.63	.6	6.41	.6	4.42	.6	3.38	.6	2.73
.7	11.49	.7	6.37	.7	4.41	.7	3.37	.7	2.72
.8	11.36	.8	6.33	.8	4.39	.8	3.36	.8	2.72
.9	11.24	.9	6.29	.9	4.37	.9	3.34	.9	2.71

TABLE FOR NUMBERING ROVING.

12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.
37.	2.70	**48.**	2.08	**65**	1.54	**100**	1.00	**190**	.53
.1	2.70	.2	2.07	.5	1.53	101	.99	192	.52
.2	2.69	.4	2.07	66.	1.52	102	.98	194	.52
.3	2.68	.6	2.06	.5	1.50	103	.97	196	.51
.4	2.67	.8	2.05	67	1.49	104	.96	198	.51
.5	2.67	**49**	2.04	.5	1.48	105	.95	**200**	.50
.6	2.66	.2	2.03	68.	1.47	106	.94	202	.50
.7	2.65	.4	2.02	.5	1.46	107	.93	204	.49
.8	2.65	.6	2.02	69.	1.45	108	.93	206	.49
.9	2.64	.8	2.01	.5	1.44	109	.92	208	.48
38.	2.63	**50.**	2.00	**70.**	1.43	**110**	.91	**210**	.48
.1	2.62	.2	1.99	.5	1.42	111	.90	212	.47
.2	2.62	.4	1.98	71.	1.41	112	.89	214	.47
.3	2.61	.6	1.98	.5	1.40	113	.88	216	.46
.4	2.60	.8	1.97	72.	1.39	114	.88	218	.46
.5	2.60	**51.**	1.96	.5	1.38	115	.87	220	.45
.6	2.59	.2	1.95	73.	1.37	116	.86	222	.45
.7	2.58	.4	1.95	.5	1.36	117	.85	224	.45
.8	2.58	.6	1.94	74.	1.35	118	.85	226	.44
.9	2.57	.8	1.93	.5	1.34	119	.84	228	.44
39.	2.56	**52.**	1.92	**75.**	1.33	**120**	.83	**230**	.43
.1	2.56	.2	1.92	.5	1.32	121	.83	235	.43
.2	2.55	.4	1.91	76.	1.32	122	.82	240	.42
.3	2.54	.6	1.90	.5	1.31	123	.81	245	.41
.4	2.54	.8	1.89	77.	1.30	124	.81	250	.40
.5	2.53	**53**	1.89	.5	1.29	125	.80	255	.39
.6	2.53	.2	1.88	78.	1.28	126	.79	260	.38
.7	2.52	.4	1.87	.5	1.27	127	.79	265	.38
.8	2.51	.6	1.87	79.	1.27	128	.78	270	.37
.9	2.51	.8	1.86	.5	1.26	129	.78	275	.36
40.	2.50	**54.**	1.85	**80.**	1.25	**130**	.77	**280**	.36
.2	2.49	.2	1.85	.5	1.24	131	.76	285	.35
.4	2.48	.4	1.84	81.	1.23	132	.76	290	.34
.6	2.46	.6	1.83	.5	1.23	133	.75	295	.34
.8	2.45	.8	1.82	82.	1.22	134	.75	300	.33
41.	2.44	**55.**	1.82	.5	1.21	135	.74	305	.33
.2	2.43	.2	1.81	83.	1.20	136	.74	310	.32
.4	2.42	.4	1.81	.5	1.20	137	.73	315	.32
.6	2.40	.6	1.80	84.	1.19	138	.72	320	.31
.8	2.39	.8	1.79	.5	1.18	139	.72	330	.30
42.	2.38	**56.**	1.79	**85.**	1.18	**140**	.71	**340**	.29
.2	2.37	.2	1.78	.5	1.17	141	.71	350	.29
.4	2.36	.4	1.77	86.	1.16	142	.70	360	.28
.6	2.35	.6	1.77	.5	1.16	143	.70	370	.27
.8	2.34	.8	1.76	87.	1.15	144	.69	380	.26
43.	2.33	**57.**	1.75	.5	1.14	145	.69	390	.26
.2	2.31	.2	1.75	88.	1.14	146	.68	400	.25
.4	2.30	.4	1.74	.5	1.13	147	.68	410	.24
.6	2.29	.6	1.74	89.	1.12	148	.68	420	.24
.8	2.28	.8	1.73	.5	1.12	149	.67	430	.23
44.	2.27	**58.**	1.72	**90.**	1.11	**150**	.67	**440**	.23
.2	2.26	.2	1.72	.5	1.10	152	.66	450	.22
.4	2.25	.4	1.71	91.	1.10	154	.65	460	.22
.6	2.24	.6	1.71	.5	1.09	156	.64	470	.21
.8	2.23	.8	1.70	92.	1.09	158	.63	480	.21
45.	2.22	**59.**	1.69	.5	1.08	**160**	.62	490	.20
.2	2.21	.2	1.69	93.	1.08	162	.62	500	.20
.4	2.20	.4	1.68	.5	1.07	164	.61	525	.19
.6	2.19	.6	1.68	94.	1.06	166	.60	550	.18
.8	2.18	.8	1.67	.5	1.06	168	.60	575	.17
46.	2.17	**60.**	1.67	**95.**	1.05	**170**	.59	**600**	.17
.2	2.16	.5	1.65	.5	1.05	172	.58	625	.16
.4	2.16	**61.**	1.64	96.	1.04	174	.57	650	.15
.6	2.15	.5	1.63	.5	1.04	176	.57	675	.15
.8	2.14	**62.**	1.61	97.	1.03	178	.56	700	.14
47.	2.13	.5	1.60	.5	1.03	**180**	.56	725	.14
.2	2.12	**63.**	1.59	98.	1.02	182	.55	775	.13
.4	2.11	.5	1.57	.5	1.02	184	.54	825	.12
.6	2.10	**64.**	1.56	99.	1.01	186	.54	900	.11
.8	2.09	.5	1.55	.5	1.01	188	.53	1000	.10

TWIST OF ROVING.

Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.
.10	.316	.38	**.80**	.894	1.07	**2.20**	1.483	1.78	**4.32**	2.078	2.49
.11	.332	.40	.82	.906	1.09	2.22	1.490	1.79	4.36	2.088	2.51
.12	.346	.41	.84	.917	1.10	2.25	1.500	1.80	4.40	2.098	2.52
.13	.361	.43	.86	.927	1.11	2.28	1.510	1.81	4.44	2.107	2.53
.14	.374	.45	.88	.938	1.13	2.31	1.520	1.82	4.48	2.117	2.54
.15	.387	.46	.90	.949	1.14	2.34	1.530	1.84	4.52	2.126	2.55
.16	.400	.48	.92	.959	1.15	2.37	1.539	1.85	4.56	2.135	2.56
.17	.412	.49	.94	.970	1.16	2.40	1.549	1.86	4.60	2.145	2.57
.18	.424	.51	.96	.980	1.18	2.43	1.559	1.87	4.64	2.154	2.58
.19	.436	.52	.98	.990	1.19	2.46	1.568	1.88	4.68	2.163	2.60
.20	.447	.54	**1.00**	1.000	1.20	**2.49**	1.578	1.89	**4.72**	2.173	2.61
.21	.458	.55	1.02	1.010	1.21	2.52	1.587	1.90	4.76	2.182	2.62
.22	.469	.56	1.04	1.020	1.22	2.55	1.597	1.92	4.80	2.191	2.63
.23	.480	.58	1.06	1.030	1.24	2.58	1.606	1.93	4.84	2.200	2.64
.24	.490	.59	1.08	1.039	1.25	2.61	1.616	1.94	4.88	2.209	2.65
.25	.500	.60	1.10	1.049	1.26	2.64	1.625	1.95	4.92	2.218	2.66
.26	.510	.61	1.12	1.058	1.27	2.67	1.634	1.96	4.96	2.227	2.67
.27	.520	.62	1.14	1.068	1.28	2.70	1.643	1.97	5.00	2.236	2.68
.28	.529	.63	1.16	1.077	1.29	2.73	1.652	1.98	5.04	2.245	2.69
.29	.539	.65	1.18	1.086	1.30	2.76	1.661	1.99	5.08	2.254	2.70
.30	.548	.66	**1.20**	1.095	1.31	**2.79**	1.670	2.00	**5.12**	2.263	2.72
.31	.557	.67	1.22	1.105	1.33	2.82	1.679	2.01	5.16	2.272	2.73
.32	.566	.68	1.24	1.114	1.34	2.85	1.688	2.03	5.20	2.280	2.74
.33	.574	.69	1.26	1.122	1.35	2.88	1.697	2.04	5.24	2.289	2.75
.34	.583	.70	1.28	1.131	1.36	2.91	1.706	2.05	5.28	2.298	2.76
.35	.592	.71	1.30	1.140	1.37	2.94	1.715	2.06	5.32	2.307	2.77
.36	.600	.72	1.32	1.149	1.38	2.97	1.723	2.07	5.36	2.315	2.78
.37	.608	.73	1.34	1.158	1.39	3.00	1.732	2.08	5.40	2.324	2.79
.38	.616	.74	1.36	1.166	1.40	3.03	1.741	2.09	5.44	2.332	2.80
.39	.624	.75	1.38	1.175	1.41	3.06	1.749	2.10	5.48	2.341	2.81
.40	.632	.76	**1.40**	1.183	1.42	**3.09**	1.758	2.11	**5.52**	2.349	2.82
.41	.640	.77	1.42	1.192	1.43	3.12	1.766	2.12	5.56	2.358	2.83
.42	.648	.78	1.44	1.200	1.44	3.15	1.775	2.13	5.60	2.366	2.84
.43	.656	.79	1.46	1.208	1.45	3.18	1.783	2.14	5.64	2.375	2.85
.44	.663	.80	1.48	1.217	1.46	3.21	1.792	2.15	5.68	2.383	2.86
.45	.671	.80	1.50	1.225	1.47	3.24	1.800	2.16	5.72	2.392	2.87
.46	.678	.81	1.52	1.233	1.48	3.27	1.808	2.17	5.76	2.400	2.88
.47	.686	.82	1.54	1.241	1.49	3.30	1.817	2.18	5.80	2.408	2.89
.48	.693	.83	1.56	1.249	1.50	3.33	1.825	2.19	5.84	2.416	2.90
.49	.700	.84	1.58	1.257	1.51	3.36	1.833	2.20	5.88	2.425	2.91
.50	.707	.85	**1.60**	1.265	1.52	**3.39**	1.841	2.21	**5.92**	2.433	2.92
.51	.714	.86	1.62	1.273	1.53	3.42	1.849	2.22	5.96	2.441	2.93
.52	.721	.87	1.64	1.281	1.54	3.45	1.857	2.23	6.00	2.449	2.94
.53	.728	.87	1.66	1.288	1.55	3.48	1.865	2.24	6.04	2.458	2.95
.54	.735	.88	1.68	1.296	1.56	3.51	1.873	2.25	6.08	2.466	2.96
.55	.742	.89	1.70	1.304	1.56	3.54	1.881	2.26	6.12	2.474	2.97
.56	.748	.90	1.72	1.311	1.57	3.57	1.889	2.27	6.16	2.482	2.98
.57	.755	.91	1.74	1.319	1.58	3.60	1.897	2.28	6.20	2.490	2.99
.58	.762	.91	1.76	1.327	1.59	3.63	1.905	2.29	6.24	2.498	3.00
.59	.768	.92	1.78	1.334	1.60	3.66	1.913	2.30	6.28	2.506	3.01
.60	.775	.93	**1.80**	1.342	1.61	**3.69**	1.921	2.31	**6.32**	2.514	3.02
.61	.781	.94	1.82	1.349	1.62	3.72	1.929	2.31	6.36	2.522	3.03
.62	.787	.94	1.84	1.356	1.63	3.75	1.936	2.32	6.40	2.530	3.04
.63	.794	.95	1.86	1.364	1.64	3.78	1.944	2.33	6.44	2.538	3.05
.64	.800	.96	1.88	1.371	1.65	3.81	1.952	2.34	6.48	2.546	3.05
.65	.806	.97	1.90	1.378	1.65	3.84	1.960	2.35	6.52	2.553	3.06
.66	.812	.97	1.92	1.386	1.66	3.87	1.967	2.36	6.56	2.561	3.07
.67	.819	.98	1.94	1.393	1.67	3.90	1.975	2.37	6.60	2.569	3.08
.68	.825	.99	1.96	1.400	1.68	3.93	1.982	2.38	6.64	2.577	3.09
.69	.831	1.00	1.98	1.407	1.69	3.96	1.990	2.39	6.68	2.585	3.10
.70	.837	1.00	**2.00**	1.414	1.70	**3.99**	1.997	2.40	**6.72**	2.592	3.11
.71	.843	1.01	2.02	1.421	1.71	4.02	2.005	2.41	6.76	2.600	3.12
.72	.849	1.02	2.04	1.428	1.71	4.05	2.012	2.41	6.80	2.608	3.13
.73	.854	1.02	2.06	1.435	1.72	4.08	2.020	2.42	6.84	2.615	3.14
.74	.860	1.03	2.08	1.442	1.73	4.11	2.027	2.43	6.88	2.623	3.15
.75	.866	1.04	2.10	1.449	1.74	4.14	2.035	2.44	6.92	2.631	3.16
.76	.872	1.05	2.12	1.456	1.75	4.17	2.042	2.45	6.96	2.638	3.17
.77	.877	1.05	2.14	1.463	1.76	4.20	2.049	2.46	7.00	2.646	3.17
.78	.883	1.06	2.16	1.470	1.76	4.23	2.057	2.47	7.04	2.653	3.18
.79	.889	1.07	2.18	1.476	1.77	4.26	2.064	2.48	7.08	2.661	3.19

TWIST OF ROVING.

Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.
7.10	2.665	3.20	10.62	3.259	3.91	14.84	3.852	4.62	19.76	4.445	5.33
7.15	2.674	3.21	10.68	3.268	3.92	14.91	3.861	4.63	19.84	4.454	5.35
7.20	2.683	3.22	10.74	3.277	3.93	14.98	3.870	4.64	19.92	4.463	5.36
7.25	2.693	3.23	10.80	3.286	3.94	15.05	3.879	4.66	20.00	4.472	5.37
7.30	2.702	3.24	10.86	3.295	3.95	15.12	3.888	4.67	20.08	4.481	5.38
7.35	2.711	3.25	10.92	3.305	3.97	15.19	3.897	4.68	20.16	4.490	5.39
7.40	2.720	3.26	10.98	3.314	3.98	15.26	3.906	4.69	20.24	4.499	5.40
7.45	2.729	3.28	11.04	3.323	3.99	15.33	3.915	4.70	20.32	4.508	5.41
7.50	2.739	3.29	**11.10**	3.332	4.00	**15.40**	3.924	4.71	**20.40**	4.517	5.42
7.55	2.748	3.30	11.16	3.341	4.01	15.47	3.933	4.72	20.48	4.525	5.43
7.60	2.757	3.31	11.22	3.350	4.02	15.54	3.942	4.73	20.56	4.534	5.44
7.65	2.766	3.32	11.28	3.359	4.03	15.61	3.951	4.74	20.64	4.543	5.45
7.70	2.775	3.33	11.34	3.367	4.04	15.68	3.960	4.75	20.72	4.552	5.46
7.75	2.784	3.34	11.40	3.376	4.05	15.75	3.969	4.76	20.80	4.561	5.47
7.80	2.793	3.35	11.46	3.385	4.06	15.82	3.977	4.77	20.88	4.569	5.48
7.85	2.802	3.36	11.52	3.394	4.07	15.89	3.986	4.78	20.96	4.578	5.49
7.90	2.811	3.37	11.58	3.403	4.08	15.96	3.995	4.79	21.04	4.587	5.50
7.95	2.820	3.38	11.64	3.412	4.09	16.03	4.004	4.80	21.12	4.596	5.51
8.00	2.828	3.39	**11.70**	3.421	4.10	**16.10**	4.012	4.81	**21.20**	4.604	5.52
8.05	2.837	3.40	11.76	3.429	4.12	16.17	4.021	4.83	21.28	4.613	5.54
8.10	2.846	3.42	11.82	3.438	4.13	16.24	4.030	4.84	21.36	4.622	5.55
8.15	2.855	3.43	11.88	3.447	4.14	16.31	4.039	4.85	21.44	4.630	5.56
8.20	2.864	3.44	11.94	3.455	4.15	16.38	4.047	4.86	21.52	4.639	5.57
8.25	2.872	3.45	12.00	3.464	4.16	16.45	4.056	4.87	21.60	4.648	5.58
8.30	2.881	3.46	12.06	3.473	4.17	16.52	4.064	4.88	21.68	4.656	5.59
8.35	2.890	3.47	12.12	3.481	4.18	16.59	4.073	4.89	21.76	4.665	5.60
8.40	2.898	3.48	12.18	3.490	4.19	16.66	4.082	4.90	21.84	4.673	5.61
8.45	2.907	3.49	12.24	3.499	4.20	16.73	4.090	4.91	21.92	4.682	5.62
8.50	2.915	3.50	**12.30**	3.507	4.21	**16.80**	4.099	4.92	**22.00**	4.690	5.63
8.55	2.924	3.51	12.36	3.516	4.22	16.87	4.107	4.93	22.08	4.699	5.64
8.60	2.933	3.52	12.42	3.524	4.23	16.94	4.116	4.94	22.16	4.707	5.65
8.65	2.941	3.53	12.48	3.533	4.24	17.01	4.124	4.95	22.24	4.716	5.66
8.70	2.950	3.54	12.54	3.541	4.25	17.08	4.133	4.96	22.32	4.724	5.67
8.75	2.958	3.55	12.60	3.550	4.26	17.15	4.141	4.97	22.40	4.733	5.68
8.80	2.966	3.56	12.66	3.558	4.27	17.22	4.150	4.98	22.48	4.741	5.69
8.85	2.975	3.57	12.72	3.567	4.28	17.29	4.158	4.99	22.56	4.750	5.70
8.90	2.983	3.58	12.78	3.575	4.29	17.36	4.167	5.00	22.64	4.758	5.71
8.95	2.992	3.59	12.84	3.583	4.30	17.43	4.175	5.01	22.72	4.767	5.72
9.00	3.000	3.60	**12.90**	3.592	4.31	**17.50**	4.183	5.02	**22.80**	4.775	5.73
9.05	3.008	3.61	12.96	3.600	4.32	17.57	4.192	5.03	22.88	4.783	5.74
9.10	3.017	3.62	13.02	3.608	4.33	17.64	4.200	5.04	22.96	4.792	5.75
9.15	3.025	3.63	13.08	3.617	4.34	17.71	4.208	5.05	23.04	4.800	5.76
9.20	3.033	3.64	13.14	3.625	4.35	17.78	4.216	5.06	23.12	4.808	5.77
9.25	3.041	3.65	13.20	3.633	4.36	17.85	4.225	5.07	23.20	4.817	5.78
9.30	3.050	3.66	13.26	3.641	4.37	17.92	4.233	5.08	23.28	4.825	5.79
9.35	3.058	3.67	13.32	3.650	4.38	17.99	4.241	5.09	23.36	4.833	5.80
9.40	3.066	3.68	13.38	3.658	4.39	18.06	4.250	5.10	23.44	4.841	5.81
9.45	3.074	3.69	13.44	3.666	4.40	18.13	4.258	5.11	23.52	4.850	5.82
9.50	3.082	3.70	**13.50**	3.674	4.41	**18.20**	4.266	5.12	**23.60**	4.858	5.83
9.55	3.090	3.71	13.56	3.682	4.42	18.27	4.274	5.13	23.68	4.866	5.84
9.60	3.098	3.72	13.62	3.691	4.43	18.34	4.283	5.14	23.76	4.874	5.85
9.65	3.106	3.73	13.68	3.699	4.44	18.41	4.291	5.15	23.84	4.883	5.86
9.70	3.114	3.74	13.74	3.707	4.45	18.48	4.299	5.16	23.92	4.891	5.87
9.75	3.122	3.75	13.80	3.715	4.46	18.55	4.307	5.17	24.00	4.899	5.88
9.80	3.130	3.76	13.86	3.723	4.47	18.62	4.315	5.18	24.08	4.907	5.89
9.85	3.138	3.77	13.92	3.731	4.48	18.69	4.323	5.19	24.16	4.915	5.90
9.90	3.146	3.78	13.98	3.739	4.49	18.76	4.331	5.20	24.24	4.923	5.91
9.95	3.154	3.79	14.04	3.747	4.50	18.83	4.339	5.21	24.32	4.932	5.92
10.00	3.162	3.79	**14.10**	3.755	4.51	**18.90**	4.347	5.22	**24.40**	4.940	5.93
10.05	3.170	3.80	14.16	3.763	4.52	18.97	4.355	5.23	24.48	4.948	5.94
10.10	3.178	3.81	14.22	3.771	4.53	19.04	4.363	5.24	24.56	4.956	5.95
10.15	3.186	3.82	14.28	3.779	4.53	19.11	4.371	5.25	24.64	4.964	5.96
10.20	3.194	3.83	14.34	3.787	4.54	19.18	4.379	5.26	24.72	4.972	5.97
10.25	3.202	3.84	14.40	3.795	4.55	19.25	4.387	5.26	24.80	4.980	5.98
10.30	3.209	3.85	14.46	3.803	4.56	19.32	4.395	5.27	24.88	4.988	5.99
10.35	3.217	3.86	14.52	3.811	4.57	19.39	4.403	5.28	24.96	4.996	6.00
10.40	3.225	3.87	14.58	3.818	4.58	19.46	4.411	5.29	25.04	5.004	6.00
10.45	3.233	3.88	14.64	3.826	4.59	19.53	4.419	5.30	25.12	5.012	6.01
10.50	3.240	3.89	14.70	3.834	4.60	19.60	4.427	5.31	25.20	5.020	6.02
10.55	3.248	3.90	14.76	3.842	4.61	19.67	4.435	5.32	25.28	5.028	6.03

SPINNING FRAMES.

It is rather difficult to add anything to the advice we have been giving constantly for years as to the use and choice of spinning frames, for conditions have not changed materially since the high speed spindle was generally accepted. Most of our recommendations as to detail of construction have been adopted by all of the regular frame builders. We must again call attention to the fact that **we do not build spinning frames ourselves,** as our position is often misunderstood. We furnish other builders with spindles, rings, separators, and lever screws, and also supply these in changing over old frames.

GENERAL CARE OF FRAMES.

New frames should be carefully leveled both ways before starting, and old frames should be gone over with a level at intervals, to see whether they need re-leveling. New frames should be oiled lavishly for several days before starting spinning and well cleaned before use to prevent soiling yarn. A new frame should be scoured after running a few weeks, wiping all the bearings out carefully. New frames have tight fits and should be watched to see that the cylinder bearings do not get hot.

Inspection and care of frames should be systematic, starting at one corner of the room and taking each frame in order.

CARE OF ROLLS.

New steel rolls may give trouble catching fibre. If so, they require polishing with whiting and oil or sawdust and oil. The whiting should be mixed with animal oil until it has the consistency of mush. The rolls should be removed from the frame and put on stands made for that purpose. The flutes should then be filled with the paste, and a piece of card clothing also. The clothing then should be rubbed lengthwise of the flutes, and every inch of the roll gone over at least 500 times, keeping the card well filled with paste all the while. If a roll is scratched, a fine file should be carefully used before it is scoured. After the scouring, a stiff brush should be used to thoroughly clean the flutes. When the rolls are put back, a piece of tallow should be crowded in between the neck of the roll and the stand. Good spinners scour their rolls several times a year.

There is considerable complaint about the wear of steel rolls in recent years. Manufacturers in various machine lines find it extremely difficult to get as good quality in steel as they did years ago, when quality seemed more important than quantity. We are not at all sure that the concentration in the steel industry and the removal of competition has bettered the product, especially for those who buy small lots and want special steels.

Leather top rolls can be cleaned while running, with a sponge dipped in a mixture of equal parts of alcohol and water. Back rolls need not be cleaned more than once a week. It is a mistake to use worn rolls as middle rolls. The middle rolls should be in as good condition as the front roll. Back rolls are not so important.

When sending worn out top rolls to be re-covered, they should be cut with a knife so as to spoil the leather and cloth as well, to ensure the use of new cloth by the roll coverer. The leather should not be put on too tight. Rolls perceptibly soft to the "feel" are preferable.

Extra top rolls should be kept in boxes made to hold them perpendicularly and apart from each other. The lid should be cushioned on the under side to prevent damage to the rolls in transit.

Back and middle rolls should be oiled twice a week on their middle bearings, and once a week on their end bearings. Rolls should, of course, be placed so as not to run against the end of the lap. The condition of the rolls is perhaps as important as any other single element in the breakage of yarn. Poor rolls will certainly reduce the number of spindles that an operative may tend. It is just as necessary to keep the saddle oiled as the end roll bearings. The pressure of the saddles will consume considerable power if they are not lubricated.

Steel rolls should not be allowed to accumulate laps. By keeping the steel rolls clean there will be much less trouble with roving winding up on the middle roll. If laps get large enough to raise the roll it makes cut yarn. Roving on the middle roll is difficult to remove, and if cut off, the roll is liable to get rough, and this makes the trouble continue.

ROLL WEIGHTING.

Stirrup levers should never rub on the steel rolls. Weight levers should be kept level so that the weight will surely exert all its force. If the weight lever sags, the weight wire may rest on the creel board. The Speakman lever screw is the neatest device known for keeping the position of stirrup and weight levers properly regulated.

ROVING GUIDES.

Roving guides should be carefully inspected to see that they are not bent or loose, and therefore delivering too near each other. If too near, a broken end may run in and make double yarn which, if it gets into the cloth, may make a second and cause considerable loss. The roving guide traverse should be kept in order so that there will be no dwell at the ends of the traverse, thereby wearing ridges in the leather rolls.

GUIDE WIRES.

Guide wires should necessarily be set so that they will deliver directly over the center of the spindle. If the spindles are changed in adjustment, the guide wires must also be changed. Guide wires should not be used after they are creased. They should be formed so as to catch kinks, or else have a separate kink catcher attached to the guide wire board. The modern stamped metal guide wire boards are now quite popular, and they have certain special advantages. Guide board lifters are now in almost universal use.

SEPARATORS.

Separators after once set practically look after themselves. They want to be kept reasonably clean, and if the blades or frames get bent out of shape, they should certainly be straightened.

RINGS.

Rings should properly be set with the spindle in the exact centre. They will wear more quickly if out of centre and break more ends. Rings are today mostly of the double flange style, and the majority are used with plate holders. Some mills test their rings for roundness, and refuse those badly out of round.

If rings are not made of proper stock or properly hardened, they will wear out rapidly, and no ring manufacturer has yet succeeded in absolutely ensuring uniformity in ring stock at all times. Modern high speeds and the change to finer yarns make extra demands on ring service, for small travellers wear rings faster than heavy travellers. Both rings and ring rails get more or less gummy and dirty in use. The entire ring rail with its rings can be properly scoured and cleaned by having a trough of proper section made, in which the whole rail may be washed in a hot solution of potash or sal soda, letting the rail soak at least half an hour. It can be rinsed later with hot water.

We know of spinners who will not take the trouble to turn rings over to use the good flange after the top one is worn. As ring manufacturers, we should have no special objection to this practice; but it is hardly economical. New rings have always started harder than old ones, no matter what the method of polishing or burnishing. This requires the use of lighter travellers at the start, and probably reduces the speed of the frame, which is generally set to starting conditions. We refer in detail to a new method of polishing in our article on Spinning Rings, to which we call attention.

Traveller clearers should be kept in proper relative position. Sometimes they get bent or loosened, according to the style of device used for the purpose.

The ring rail should naturally be kept level, so that the travellers will move around on the rings in a horizontal plane. Careful inspection with use of a spirit level will assist in finding errors.

TRAVELLERS.

Some spinners merely put on new travellers when the old ones break off, and others replace whole sets at intervals. Spinners can be taught to detect worn travellers by feeling of them when piecing an end, and if they make the change at this time they save themselves trouble, providing they are running on the first mentioned plan. Until recent years, it has been customary to use the same bow travellers and the same size ring flange for nearly all yarn numbers. It has been found preferable to use special flanges with small bow travellers for light yarn.

It is difficult to give advice on the weight of traveller, as the conditions of spinning vary so much. Light travellers make more elastic yarn, but it is not always true that light travellers will reduce end breakage. Heavy travellers get more momentum and help out on weak spots in the yarn through the very momentum obtained. A heavy traveller winds a harder bobbin. Any overseer can make his own experiments by trying different travellers on different frames, keeping a record of the ends broken down while running and while doffing.

LIFTING RODS.

Lifting rods are often too tight on new frames, and should be carefully watched at the start. Later, they may stick from dirt or lint getting into the bearings, and a protection like the Shaw & Flynn cleaner is advisable.

SPINDLES.

New frames should have their spindles banded and run bare for some hours before they are set to the rings. They will need liberal oiling at the start, and for the first two weeks at least.

In setting spindles to rings, it is customary to use a bobbin with a wooden cylinder attached, made slightly less than the ring's inside diameter. Some spindle setters place the ring rail at the middle of the bobbin when setting, so that any variation between top and bottom is divided. A more accurate method is to set spindles to the rings at the bottom, then run the rail up. Any spindles not found in the center of the ring will now need papering, as they are not in proper line. By running the rail up and down a few times and re-papering, spindles can be made to run in the center of the ring at all points. The method of using a spirit level on top of a spindle is not absolutely correct to meet the conditions for the lifting rods may not be perpendicular. Some setters set the spindles with a wooden bobbin at the center of the traverse and then let full bobbins be spun, noting whether the rings are central by seeing how the bobbin runs in the ring. Never forget that the guide wires need careful re-setting after the setting of the spindles is accomplished. Where only a few spindles are changed in position this is sometimes forgotten.

Spindles that vibrate indicate bad bobbins, crooked blades, poor fit of bolster, or dry bearings. A spindle fault will often be corrected by supplying a different bolster. While a vibrating spindle may be crooked, it does not follow that all crooked spindles will vibrate, for the loose bearings used accommodate themselves to faults in the spindle. A spindle which runs well without a bobbin and badly with a bobbin, usually signifies some fault in the bobbin itself, unless tests with several bobbins show the trouble is elsewhere. Lack of oil will make any spindle vibrate, whether straight or crooked. A vibrating spindle wastes its oil rapidly. This can be shown by holding a piece of paper opposite the edge of the whorl. All spindles waste oil more or less, though we have found by actual tests that our snout spindles can run at least two months, if properly oiled at the start. We do not mean that it is safe to let them run that length of time, for oilers are careless. The oil that is wasted by running over the base, and also by being thrown off the whorl, is not necessarily a disadvantage. The bands absorb considerable of it from the air, and this causes the fibres of the bands to lie closely, and the bands wear longer. We know this for we have tested spindles that used no oil, and their bands would wear very rapidly by perceptibly throwing off loose fibres.

As to choice of oil for spindles, we know of mills using heavy oil because they had bad bobbins which caused the spindles to vibrate and therefore waste oil excessively. Heavy oil consumes large amounts of power. Our own experience leads us to recommend light gravity oils, from 33 to 38. The price should be a small consideration, for cheap oil can prove expensive in many ways. We have found spindles so rusty from use of oil with moisture in it that they used 50 per cent. more power than the same spindles used after cleaning. Moisture in oil stains it a dirty, brownish color. Some oils gum and stick, leaving a varnish like deposit on the spindle, which necessarily increases the power to drive it. English spinners make a practice of cleaning out spindle bases so frequently that their spindles are often arranged so that the lower end of the base can be removed. We believe this quite unnecessary if good oil is used. If poor oil has been used, it certainly will pay to clean the spindles thoroughly. This may be done by taking bolsters out and soaking them in benzine, naphtha, gasoline, or whatever the name may be for the cleaning fluid; or they can be cleaned by blowing through them with a steam jet. The spindle bases can be pumped out by a syringe, and if there is much dirt in the bottom it can be swabbed out by waste on a stick. Bases can also be removed and cleaned with a steam jet if that is thought preferable.

The second hand should be held responsible for the correction of vibrating spindles. With the Draper type, the adjustment of the bearing usually corrects vibration. With other types, new bolsters may be necessary, and with either type, a badly crooked spindle should be replaced. Spindle bases should be kept reasonably clean, for the lint sometimes gets sucked in between the whorl and the base to such an extent as to slow the spindle and make slack yarn.

BANDING.

On new frames, the new cylinder will wear bands rapidly. Bands will also wear faster than usual when driving bare spindles in starting up a frame. Care should be taken to see that bands are made of uniform weight. If the band boy gets careless, he may neglect to put the proper number of strands in the band. With marked bands, spindles can be banded while running without necessarily having the tension too tight.

We have always recommended a band pull of two pounds for the ordinary size spindle. This does not mean that the band should only pull two pounds when put on. It should then pull from three to four pounds, according to the size. We believe in light bands, as they cannot be tied too tightly, and also because they will break of themselves if getting too

tight in use. Bands act curiously in use, some growing slacker through stretching, and others growing tighter through absorption of oil and by loading up with lint. If bands are near a vibrating spindle, they will get more oil than ordinary and these bands will grow tighter than others. Spinners have advised brushing the cylinders at periods to prevent accumulation of lint by the bands. Loose bands often run up above the whorl where they drive the spindle from a smaller diameter, making it run faster and putting in more twist. If the spindle is making filling yarn, the extra twist will cause it to kink badly. Inspection should prevent the making of slack yarn through too slack bands, for slack yarn is one of the greatest evils in cotton mill practice. It should, of course, be detected by the spinner or the spooler tender, but sometimes it gets by into the warp when one end may cause the weaver continual labor and trouble until the whole warp is woven out. The second hand should go over the bands when frames are stopped for cleaning, cutting off all which are too tight or too loose.

BOBBINS.

New bobbins should be tested before use, as they may change materially after shipment. They should also be tested at intervals while in use, especially filling bobbins, which are liable to warp and swell excessively from absorbing moisture. Bad bobbins not only make spindles vibrate, wasting their oil and running dry, but they also rise up on the spindles, causing the yarn to run down over the bottom and also often making slack yarn. Bobbins may also be perfectly concentric and straight, but rise up on the spindles because they do not fit properly. There are many conflicting theories about proper fit of bobbins. The same theory will not fit all cases, for spindles vary in design. Short spindles usually have a tapering top, while long spindles have a cylindrical top. Bobbins will often drive well with a taper top spindle fitting closely at the top, while they might drive better on a cylindrical top spindle if fitting loosely. The cups supplied to spindles are merely to prevent the splitting of bobbins. It is not intended that the bobbin should be driven by the cup, although it does no harm if the bobbin fits both the cup and the whorl. If the bobbin is too small for the whorl and gets wedged down on it, it will often shake loose and rise much worse than a bobbin which fits loosely. If a bobbin is to fit loosely at the whorl, it should fit tight at the top. Poor bobbins can be re-reamed, but they should be tested after reaming and thrown away if they do not then run well.

Bobbins should be made from thoroughly seasoned stock.

The bobbin maker is personally responsible for any trouble from this source. Warp bobbins should be at least 7-8 of an inch in diameter, for yarns number 28 and under. They should have some protection at the bottom in the shape of ring or equivalent to prevent splitting. The upper bearing should be at least 3-4 of an inch long. Bobbins ought to be oil soaked as well as shellacked. The difference in life will more than offset the difference in cost.

GENERAL DETAILS.

Loose pulleys should have their collars set snugly and their bearings kept well fitted. They should be a little less in diameter than the tight pulleys, as they do no work and do not need so tight a belt. A shaking pulley can communicate wear and vibration to the whole frame. The driving pulley should be of good size, else it will need a tight belt, consuming considerable power at the cylinder bearing. If frames are to run at excessively high speed, they should have good sized cylinders, even if this necessitates wide frames. The improvement in rings and spindles allows an increase in speed beyond the standards of a few years back. Black oil must always be considered as evidence of unnecessary wear, except in cases where the bearings are new.

PURCHASE OF NEW FRAMES.

There are several excellent makes of spinning frame sold in this country. Some of the builders buy their spindles, rings, separators and lever screws from us. Others supply their own make. Even those who make their own specialties, will usually furnish our parts, **if the buyers insist.** We know our spindles are superior to any manufactured, because we have not only had more experience than any other builder in the making and testing of spindles, but we employ processes which are frankly recognized as superior, several of which are protected by patents. During the control of the spindle situation by fundamental patents, we allowed other licensees of the Sawyer Spindle Company to duplicate some of our machinery, but recently we have decided to retain the use of our improved patented processes for our own product. We urge the choice of our own spindles as made in our own works to customers, from our knowledge of their detail as well as their design. We furnish all the regular trade varieties.

As to rings, we are equally positive as to recommendation of our own product, and for very similar reasons. We explain more in detail in a different section of this book.

Our separators are well known and unequalled in efficiency.

Our lever screws are copied since our patent ran out, but we believe the product of our own shops is more accurately made and more carefully inspected than those made by other parties, for we have a special department for turned work of this nature, in which the entire equipment is of tools of our own design and manufacture.

Referring to general details of the frame, it is growing customary in foreign countries to use frames of great length with many spindles. We doubt the expediency of this movement. There may be a slight saving in floor space, but the extra power demands a tighter belt, there is more torsion on the rolls and cylinder, and a greater proportion of spindles are stopped for doffing or other purposes. There is possibly more difficulty in keeping the long frames properly leveled. Purchasers of frames should anticipate the possible increase in speed by having extra weight and good width of frame, with fairly large sized band cylinders. With over-head drive there should be a flange on the outside of the tight pulley to prevent the belt from running off between the frame and the pulley. Nearly all frames are now made with outside bearings.

SPINDLE POWER.

The author has had entire charge of the power testing of spindles for the Draper Company and its predecessors for nearly twenty years, and has arrived at certain general conclusions, which are briefly stated as follows:

Given proper conditions, there is little difference in power between the trade types of high speed spindle of similar size which we sell. We have tried countless variations in dimensions and fits, but we find that if we loosen the bearings and the fits to save power, we get more vibration under certain conditions. Nothing yet tested has equalled our present type, taking power, consumption and general smoothness of running into proper consideration. **Variations in power between different types of spindle of the same general class are slight as compared with the variations produced by improper conditions.** These conditions are not presented by variations in the spindles themselves, so much as in the conditions under which they are used. If the spindle is crooked, it will naturally vibrate more, and thus take more power. Large, heavy spindles, naturally take much more power than the lighter type, and it is possible that a heavy pattern is often selected for work that a light type could accommodate.

As to the conditions of use, I believe that poor oil is possibly the most common consumer of power. A combination of low gravity oil with the rust produced by moisture or acid present in it represents pretty near the maximum of evil. We have been hammering away to get spindle users to buy good light oil for years, and as we have no personal interest whatever in the matter, our advice is certainly unprejudiced. Good oil is necessarily more expensive; not necessarily because of its composition, but because of the greater care necessary in its manufacture. The difference in price between a good oil and poor oil is nothing as compared with the real saving obtainable.

It is understood we are referring to our own types of spindle, with bearings enclosed in an oil bath. Bearings of Sawyer spindles, or mule spindles, very properly require heavier oil on the upper bearings.

A tight band pull adds perceptibly to the power consumed; in fact, it may run to excessive limits. Spinners are educated now-a-days so that we very rarely find band pull of six to ten pounds, as in former years.

Poor bobbins add to power by causing the spindles to vibrate, and so do rings that are out of center. The other elements of the frame, such as cylinder and rolls, naturally take extra power if the bearings are poorly oiled, or if the rolls are

too heavily weighted. A tight driving belt on the frame pulley will add to the whole power of the frame.

The work put on the spindle by the act of spinning,—that is, carrying the thread and traveller around on the ring, is a very important element in power consumption, but it is a necessary element and not easily modified except by possible variation in the weight of the traveller and the size of the ring. The pull on the yarn varies in proportion to the diameter of the bobbin compared with the diameter of the ring, especially when spinning near the bare bobbin. The modern practice of spinning with larger bobbins and larger ring diameters, naturally adds to power, unless the speed be reduced. The question of speed naturally enters into the question of power; that is, the power consumed **per product** is necessarily larger as the speed increases. The power consumed by a frame varies with conditions of atmosphere and temperature. Excess of moisture in the air causes all the bands to become tighter. When a mill gets cold over night, the oil congeals more or less, making the frames harder to start in the morning. Bands also contract while at rest. Spindles usually consume less power after running sometime, as they smooth their bearings and cure any trouble in tight or cramped bearings.

PRACTICAL METHODS OF POWER TESTING.

If data is needed to determine what style or size of spindle is to be used, it would be first advisable to consult the maker of the spindles as to the data he himself has obtained. The power tests of a whole frame for this purpose are apt to be misleading, for the spindles themselves only consume a fraction of the whole power, and there may be serious variations in other parts of the frame. These variations are certainly present where one frame is tested against another.

If the test be made to determine the selection of an oil, it is best to make the tests on the same frame and the same spindles, changing the oil in the bases with thorough cleansing in between. Interesting tests can be made to show the difference between a frame as ordinarily run and the same frame after being put into proper condition. In order to have the test amount to anything it should be made by a man who takes the greatest of pains to have all the conditions uniform, or by a man who has had sufficient experience to properly allow for variation in conditions; for instance, a frame tested Monday morning would show worse results than on Tuesday morning, simply because the resting over Sunday would seriously affect the bands, and also the oil, if the mill were cool in the interim. Frames run lighter in the afternoon as a rule than in the morn-

ing, and they run lighter on a warm, sunny day than on a cool, muggy day.

Since there are many possibilities for unexpected variations, it is well not only to make several tests, but to definitely compare the different elements of power consumption which make up the total. To do this, it is advisable to know in each test how much power is consumed by the rolls, gearing and builder, how much by the drag of the yarn and how much by the load on the spindle. I advise the following method of power testing to meet these conditions:

Take records of the power for several minutes just before doffing time, then take the power records for several minutes after doffing. Take all readings when the rail is at the center of the traverse. By adding these records and dividing by 2, the average power of the frame spinning is approximately obtained. Now, break the ends down, and keep the rolls running and record the power. Next, throw the rolls and builder out of gear and run the spindles with their bobbins. The difference between the latter two records will give the power consumed by the rolls, gears and builder. Now, take the small bobbins off and replace them with the full bobbins, running the spindles without rolls as before. By adding this record to the record of the small bobbins without rolls, and dividing by 2, we have the power taken by the average weight of the yarn load and bobbin with the spindle. Now, take the bobbins off and run the spindles bare. Subtracting this record from the former one will show the power taken by the average yarn load and bobbin. If necessary to differentiate further, it is possible, of course, to get the power of the average yarn load without the bobbin, by putting bare bobbins on the spindle and finding the actual power taken by the bobbin without yarn. If the power taken by the average yarn load, bobbin and spindle, is subtracted from the average of the entire power spinning, after eliminating the power of the rolls, gears and builder, it is possible to determine the power taken by the drag of the traveller and the resistance of the air to the yarn while spinning. The power taken by the cylinder can be easily found, of course, by cutting off bands and running the cylinder by itself. This is hardly necessary for ordinary purposes.

If these elements of power are sub-divided on comparative tests, it is easy to see whether the conditions are uniform, for there should be no perceptible variation between the power taken by any of these elements with the same spindles.

Spindles of different construction show curious variations in the division of power between these various elements. It is easy to discover what type of spindle carries its yarn best and which one is best adapted to meet the strain of the pull of the yarn. It

must always be borne in mind that the percentage of gain by one frame of spindles over another by no means shows the true proportionate worth of the spindles themselves, for a spindle that is materially better than another has its percentage considerably reduced when several other elements of power consumption are added into the total result.

In testing oils, it is not necessary to spin if a quick test is wanted, as any real difference in the quality of the oil will show on the bare spindles.

No comparative power tests are of the slightest use unless the band tension is the same, or unless proper variation of proportion is figured. A band scale is indispensable. In preparing a frame for scientific tests, it should be accurately levelled, cleaned and scoured. The spindles, rings and guide wires should be set with accuracy. The spindles themselves should be thoroughly cleaned by removing all the oil and dirt with a pump and swab, or steam jet. If the spindles have been adjusted badly, the fit should be made uniform throughout. New bands should be applied, running them enough to take out the first stretch, then carefully weighing and cutting off any abnormally tight or loose bands till the average is as near the standard two pounds as possible. The band tension should be weighed at least twice a day while tests are going on, and the average pull made uniform by new bands, as necessary.

If spindles with adjustable bearings are tested against spindles with straight bearings, the looseness of fit in the adjustable bearing should be made as uniform as possible, with the average fit in the other. I mention this because I have seen spindles submitted for comparative tests in which the fits were much looser than in regular trade practice. A loose bearing will reduce power, unless the looseness is carried to sufficient excess to seriously affect the running of the spindle.

The size of the band affects the power problem, not necessarily because it is tied tighter, but also because there is more air resistance. The weight of a spindle is not so important as the size of its bearing. I have seen spindles made so small and short at the bearing section that they consumed more power than larger spindles because they had to be fitted quite tightly in their bearings to prevent vibration. If a spindle blade vibrates through the actual bending of the blade itself, it will consume much power. The taper bearing blade is stronger than any other in comparison with the average size of its bearing.

We have given special attention to the subject of spindle power ever since the Sawyer spindle was invented. The tests during this period have included many comparisons to

determine value of different inventions, many of which have never been seen by our customers. There are certain general conclusions reached by these comparisons which may have value as preventing repetition of useless experiments.

Ball bearing spindles offer an interesting field for power tests. There is no question but that ball bearing spindles can be made to run with light consumption of power; but they are expensive in construction, and it is difficult to make them in large lots so that they will run uniformly.

Oilless bearing spindles have been found to consume little power, but their bands wear out rapidly, and there are objections not yet met satisfactorily, so far as our own experience has determined.

Anti-friction step bearings are quite common as inventions, but the vertical friction of a spindle is so little that it is hardly perceptible in the general showing.

Spindles have been constructed with bearings and fits so loose that they could be driven to speed by the ordinary store string, but they had certain peculiarities and eccentricities of motion so that they could not run constantly in the center of the ring. Spindles can be designed to run well for short periods that would wear out rapidly in constant use. Others might run well for a few days, but are so designed that they cannot hold oil.

To anticipate possible suggestions, will say that we have tried spindles with loose bearings and tight bearings, long bearings and short bearings; bolsters with many degrees of looseness, bolsters locked, unlocked and spring locked; spindles with pointed steps and flat steps; bolsters with different packings, no packings, and many forms of spring packing; spindles with self-adjustable fits; spindle blades with different tapers, different lengths, and different diameters,—in fact, almost every mechanical variation that the ingenuity of many minds have been able to suggest during a very long period.

POWER CONSUMPTION ANALYZED.

In spinning No. 28 yarn with a band tension of 2 lbs. on $1\frac{3}{4}$ ring, the power units are approximately as follows:

Power consumed by cylinder,	2.5	per cent.
Bands and bare spindles,	50.	" "
Bare bobbins,	2.5	" "
Average yarn load,	15.	" "
Traveller pull,	22.	" "
Rolls, builder and gearing,	8.	" "
	100	

The proportions will vary according to the oil, the size of ring, speed, etc.

It is difficult to advise just how much power will be taken by any particular conditions, because the range of actual experience in power testing is too limited to cover the many possible combinations. Neither is it safe to figure out this proportionate variation to allow for differences in conditions. For example, it is scientifically proper to assume that increase of speed will increase the power taken inversely as the square of the speeds. In actual practice, the results do not conform to this assumption; not for any fault in the laws of science, but because of changes in conditions which might not always be taken into consideration. For instance, if we start with a certain band tension, at a certain speed, an increase of speed will lessen the band tension. An increase of speed will also raise the temperature of the oil. As a matter of fact, the power taken by any one spinning frame does not increase in the degree expected, but in a less degree.

TABLE OF SELECTED TESTS.

Data is obtained from several printed publications and the Draper Co. records. They are largely taken from outside sources.

Tests with band pull of 2 lbs. average, unless otherwise stated, on warp yarn.

NO. OF YARN	SIZE SPINDLE	DIA. OF RING	LENGTH TRAVERSE	REV. FRONT ROLL	REV. SPINDLE	SPINDLES PER H. P.
6	large Whitin	2	7¼	161	5,900	85
8	"	2	7¼	158	6,700	74
10	"	2	7¼	154	7,250	68
12	medium Whitin	2	7	150	7,750	76
14	"	2	7	146	8,100	72
16	"	2	7	141	8,450	70
18	"	2	7	138	8,750	72
	49 D Rabbeth (2.75 band pull)	1¾		129	7,890	84
20	medium Whitin	2	7	134	8,950	74
24	"	2	6½	125	9,200	76
28	standard Whitin	1¾	6½	120	9,500	76
	49 D Rabbeth	1¾	6	117	9,300	79
32	standard Whitin	1¾	6½	114	9,500	78
36	"	1¾	6½	108	9,700	78
40	"	1⅝	6	106	9,700	80

40	Sherman (3.5 band pull)	1 3/8	5 1/2	104	9,500	74
43	49 D Rabbeth (1.8 band pull)	1 1/2	5 3/8	96	9,300	100
45	standard Whitin	1 1/2	6	100	9,700	83
50	"	1 1/2	6	94	9,700	86
	Draper No. 2.	1 1/2	6		9,497	92
60	standard Whitin	1 1/2	6	86	9,500	90
70	"	1 1/2	6	80	9,500	94
80	"	1 1/2	6	76	9,300	100
90	"	1 3/8	5 1/2	72	9,100	108
100	"	1 3/8	5 1/2	66	8,700	114
110	"	1 3/8	5 1/2	64	8,500	127

Tests on Filling Yarn, 2 Pounds Band Pull.

8	medium Whitin	1 1/2	7 1/2	178	5,450	140
14	"	1 1/2	7	162	6,700	120
18	"	1 1/2	7	154	7,200	110
20	"	1 1/2	7	150	7,400	98
28	standard Whitin	1 3/8	6 1/2	140	7,900	86
36	"	1 3/8	6 1/2	129	7,900	90
50	"	1 1/4	6	109	7,900	93
70	"	1 1/4	5 1/2	92	7,800	100
100	"	1 1/4	5 1/2	75	7,200	117

Exceptional Condition Tests on Warp Yarn.

Frame and Spindles Under Almost Perfect Conditons.

40	standard Whitin (1 1/2 band pull)	1 3/8	5 1/2	104	9,500	112
43	49 D Rabbeth (special banding)	1 1/2	5 3/8	98	9,500	113

Comparison of Poor Mill Conditions, with Frame as Cleaned up.

28	Sherman (2.25 band pull) As running in mill.	1 3/4	6		7,500	72
28	Same after Frame and Spindles put into condition with new light Oil. (2.25 band pull)	1 3/4	6		7,500	90

Comparison of Oils, all Other Conditions Equal.

40	49 D Rabbeth (1 1/2 band pull) Common mill Oil.	1 1/2	5 1/2	104	9,500	111
40	Same with light Oil. (1 1/2 band pull)	1 1/2	5 1/2	104	9,500	121

COMPARISON OF BAND PULL, OTHER CONDITIONS EQUAL.

28	Special Spindle	1¾	7	8,500	
	1 lb. average pull				73
	1.5 lb. " "				69
	2 lbs. " "				65
	2.5 lbs. " "				62
	3 lbs. " "				59
	3.5 lbs. " "				55
	4 lbs. " "				52
	4.5 lbs. " "				50
	5 lbs. " "				47
	5.5 lbs. " "				45

COMPARISON OF POWER TO SPEED ON SAME FRAME WITH BAND PULL OF 2 POUNDS (BAND PULL TAKEN WITH SPINDLES NOT RUNNING).

28	Special Spindle	1¾	7	8,500	85
				9,000	76
				9,500	72
				10,000	67
				10,500	64

The above figures are not given with any idea of instituting comparisons between various types of spindle. The tests of different spindles on the same number of yarn as grouped, were not made under similar conditions. We know, of course by our own comparative tests, just how the trade spindles do compare, and have always been perfectly frank in recommending the various Rabbeth or Draper types as superior in light running.

PRODUCTION TABLES.

The details of the figures given for production and speed do not coincide with those given by any other authority. In order to prepare them we asked for information from every mill having frame spindles in this country, and while a statistical table must necessarily conform to some rule of progression, the results indicated can be paralleled by actual facts.

These tables are not made up from average results, but rather represent a high average, though not a maximum. Most tables figure out revolutions of the front rolls in decimals, from an assumed spindle speed. Our tables give roll speed, spindle speed and hank production in even figures for greater convenience of application. The warp twist is figured from the ordinary warp twist table, up to and including No. 35. This standard is made by multiplying the square root of the number of the yarn by 4.75. The use of longer stapled cotton for numbers above 35 has led to a reduction in twist for finer yarns. In our tables we use a twist from Nos. 40 to 80, figured by multiplying the square root of the number of the yarn by 4.50. From 36s to 39s, inclusive, the twist is simply graduated between the two standards. From 80 to 110 the twist is figured by multiplying the square root of the number of the yarn by 4.25.

It is, of course, impossible to meet all the various conditions of twist in a table of this nature, as yarn is used for so many purposes. We have tried to make it conform to the practice of the majority of mills in this respect.

The production in hanks is necessarily figured from the delivery of the front roll, making proper allowance for doffing, and the contraction of the yarn due to the twist. Of course more time must be allowed for doffing with coarse yarn. The revolutions of the spindle must be sufficient to not only put in the necessary twist per inch, but also to wind the yarn on the bobbin.

In our table of filling yarn the twist is computed from a varying standard as follows:

Up to, and including No. 25, the mule filling twist of 3.25 times the square root is used, as returns from the mills seem to show that the coarser numbers can be spun with this amount of slackness, to advantage. From No. 25 to No. 30, inclusive, the twist is figured at 3.50 times the square root, and above No. 30 at 3.75, which is the mule warp twist.

It has been thought useless to give theoretical spindle speeds, as the usual facilities for counting speed are not adapted to fine results. No variation is figured at less than one hundred turns per minute. This seems near enough, as the

speed varies, more or less, from frame to frame and from hour to hour.

The comparative tables show actual figures from mills as compared with the computation of estimated progression. Figures from the standard table are first placed opposite the number of yarn and figures then follow, giving actual results on the same yarn. We show one or two instances where the mill results are greatly in excess of our own table. We could have given many more, if necessary, to prove our own recommendations moderate. It is not wise to rely absolutely on the spindle speeds that are quoted from the mills, as they are often estimated, or figured without allowing for slip of bands.

CONSTANTS.

While certain twist constants are universally used in figuring textile operations, the application of this principle, is not, so far as we know, carried out for convenience in other relations. Mr. George A. Vaughan, superintendent of the Putnam Mfg. Co., has sent us the following data, which he uses in his own mill. Of course, by following the same principle, one could work out other constants, for application in other mills where the conditions may be different.

PRODUCTION CONSTANTS.

CONSTANTS.	SPEEDERS.
.467 for $1\frac{1}{4}''$ roll. .421 for $1\frac{1}{8}''$ roll.	Rule—Divide .467 (slubbers and intermediate), or .421 (fine speeders and jacks), by the hank number and multiply the quotient by the revolutions per minute of the front roll. The result is the production at 100 per cent. in lbs. per spindle per week of 60 hours.
	SPINNING FRAMES.
.374 for $1''$ roll.	Rule—Divide .374 by number of yarn and multiply the quotient by R. P. M. of the front roll. The result is the production at 100 per cent. in lbs. per spindle per week of 60 hours. For week of 58 hours the constant would be .362 and for 66 hours, .411.

MULES.

7.143 for 60″ stretch.
7.619 for 64″ stretch.
7.976 for 67″ stretch.

Rule—Divide the constant by the number of yarn, and multiply the quotient by the number of stretches per minute. The result is the production at 100 per cent. in lbs. per spindle per week of 60 hours.

LOOMS.

.100

Multiply 100 by the number of picks per minute and divide by the picks per inch. Result is the production at 100 per cent. in yards per week of 60 hours.

The spinning constants given above allow no time for doffing, etc. The table on page 62 gives a system of progressional constants in which allowance for loss of time has been made in conformity with the results as shown in our production table. It will be found useful for conditions where it is desirable to know what production should be obtained from frames having roll speeds which differ from those we have assumed.

For instance, taking the constant .328 for No. 28 warp yarn on 58 hours run we find production at the roll speed given of 124 turns as follows:

28) .328	.0117
28	124
48	468
28	234
200	117
196	1.4508 *Answer.*

Our warp production table gives 1.45 or the same result. Now to find the comparative production on No. 28 warp yarn at 120 revolutions of the front roll, multiply .0117 by 120=1.40.

For No. 29 to No. 34 yarn the same constant would be used; that is, wherever there is a blank, use the constant given above it.

Production Table of Ring Warp Yarn.

Front Roll 1 Inch in Diameter.

No. of Yarn.	Size of Spindle.	Gauge of frame.	Diameter of ring.	Length of traverse.	Twist per inch.	Revolutions of front roll per minute.	Revolutions of spindle per minute.	Hanks per spindle per day of 10 hours.	Pounds per spindle per week of 58 hours.	Pounds per spindle per week of 60 hours.	Pounds per spindle per week of 66 hours.
4	Draper No. 4.	3 inches.	2¼	7 or more	9.50	204	6200	10.50	15.22	15.75	17.32
5					10.62	200	6800	10.40	12.06	12.48	13.72
6					11.64	196	7300	10.30	9.95	10.30	11.33
7					12.57	192	7700	10.20	8.45	8.74	9.61
8					13.44	188	8100	10.10	7.32	7.57	8.33
9					14.25	184	8400	10.00	6.44	6.66	7.33
10			2⅛		15.02	180	8600	9.80	5.68	5.88	6.46
11					15.75	176	8800	9.60	5.06	5.23	5.76
12					16.45	172	9000	9.40	4.54	4.70	5.17
13					17.13	168	9000	9.20	4.10	4.24	4.67
14					17.77	164	9000	9.00	3.72	3.85	4.24
15					18.40	160	9300	8.80	3.40	3.52	3.86
16					19.	156	9400	8.60	3.11	3.22	3.54
17					19.58	152	9400	8.40	2.86	2.96	3.26
18					20.15	148	9400	8.20	2.64	2.73	3.00
19					20.71	144	9400	8.00	2.44	2.52	2.77
20			2		21.24	140	9400	7.80	2.26	2.34	2.57
21					21.77	138	9400	7.70	2.12	2.20	2.42
22					22.28	136	9500	7.60	2.00	2.07	2.28
23					22.78	134	9500	7.50	1.89	1.95	2.15
24					23.27	132	9600	7.40	1.78	1.85	2.03
25					23.75	130	9600	7.30	1.69	1.75	1.92
26					24.22	128	9700	7.20	1.60	1.66	1.82
27					24.68	126	9700	7.10	1.52	1.57	1.73
28					25.13	124	9700	7.00	1.45	1.50	1.65
29					25.58	122	9800	6.90	1.38	1.42	1.57
30			1¾		26.02	120	9800	6.80	1.31	1.36	1.49
31					26.45	120	9900	6.80	1.27	1.31	1.44
32					26.87	118	10000	6.70	1.21	1.25	1.38
33					27.29	118	10100	6.70	1.17	1.21	1.34
34					27.70	116	10200	6.60	1.12	1.16	1.28
35					28.10	116	10300	6.60	1.09	1.13	1.24
36					28.17	114	10200	6.50	1.04	1.08	1.19
37					28.24	114	10100	6.50	1.01	1.05	1.15
38					28.31	112	10000	6.40	.97	1.01	1.11
39					28.38	112	10000	6.40	.95	.98	1.08
40	Draper No. 2.	2¼ inches.	1⅝	6½	28.46	110	10000	6.30	.91	.94	1.03
41					28.81	110	10000	6.30	.89	.92	1.01
42					29.16	108	10000	6.20	.85	.88	.97
43					29.50	108	10000	6.20	.83	.86	.95
44					29.65	106	10000	6.10	.80	.83	.91
45					30.19	106	10000	6.10	.78	.81	.89
46			1½	6	30.51	104	10000	6.	.75	.78	.86
47					30.85	104	10000	6.	.74	.76	.84
48					31.18	102	10000	5.90	.71	.73	.81
49					31.50	102	10000	5.90	.69	.72	.79
50			1⅜	5 to 5½	31.81	100	10000	5.80	.67	.69	.76
55					33.37	96	10000	5.60	.59	.61	.67
60					34.86	92	10000	5.40	.52	.54	.59
65					36.28	88	10000	5.20	.46	.48	.52
70					37.65	84	10000	5.	.41	.42	.47
75					38.97	80	9800	4.80	.37	.38	.42
80					39.08	78	9600	4.70	.34	.35	.38
85					39.18	76	9400	4.60	.31	.32	.35
90					40.32	74	9400	4.50	.29	.30	.33
95					41.22	72	9400	4.35	.26	.27	.30
100					42.50	70	9400	4.20	.24	.25	.27

Comparative Production Table of Ring Warp Yarn.

No. of Yarn.	Size of spindle.	Gauge of frame.	Diameter of ring.	Length of traverse.	Twist per inch.	Revolutions of front roll per minute.	Revolutions of spindle per minute.	Hanks per spindle per day of 10 hours.	Pounds per spindle per week of 58 hours.	Pounds per spindle per week of 60 hours.	Pounds per spindle per week of 66 hours.
6	Draper No. 4	3	2¼ 1⅞	7 7	11.64	196 180	7300 6800	10.30	9.95	10.30	11.33 10.10
10		3	2⅛ 1⅞	7 7	15.02	180 178	8600 8500	9.80	5.68	5.88	6.46 6.68
12		3	2⅛ 1⅞	7 6	16.45	172 185	9000 8700	9.40	4.54	4.70	5.17 5.40
13		3	2⅛ 2	7 7	17.13	168 160	9000 8500	9.20	4.10	4.24	4.67 4.48
14		3	2⅛ 1½	7 6¼	17.77	164 169	9000 8100	9.00	3.72	3.85	4.24 4.66
18		2¾	2 1⅞	7 6	20.15	148 150	9400 8800	8.20	2.64	2.73	3.00 3.37
20		2¾	2 1¾	7 7	21.24	140 140	9400 9400	7.80	2.26	2.34	2.57 2.49
22		2¾	2 1¾	7 6	22.28	136 136	9500 9500	7.60	2.00	2.07 2.10	2.28
25		2¾	1¾ 1⅝	6½ 7	23.75	130 130	9600 9500	7.30	1.69 1.69	1.75	1.92
26		2¾	1¾ 1⅝	6½ 6	24.22	128 136	9700 10000	7.20	1.60	1.66	1.82 1.80
28		2¾	1¾ 1½	6½ 5½	25.13	124 122	9700 9750	7.00	1.45 1.47	1.50	1.65
30		2¾	1¾ 1¾ 1½	6½ 6½ 5½	26.02	120 120 122	9800 9750 10000	6.80	1.31 1.34	1.36	1.49 1.48
32		2¾	1⅝ 1¾ 1⅝	6½ 6 6¼	26.87	118 115 118	10000 9500 9600	6.70	1.21	1.25 1.30	1.38 1.35
34		2¾	1⅝ 1⅝	6½ 6¼	27.70	116 120	10200 9500	6.60	1.12	1.16 1.20	1.28
38		2¾	1⅝ 1⅝	6½ 6¼	28.31	112 112	10000 9700	6.40	.97	1.01 1.00	1.11
40		2¾	1⅝ 1⅝	6½ 6¼	28.46	110 115	10000 10000	6.30	.91 .95	.94	1.03
42		2¾	1½ 1⅝	6 6	29.16	108 100	10000 9200	6.20	.85 .81	.88	.97
50		2¾	1½ 1⅝	6 6	31.81	100 100	10000 10000	5.80	.67 .67	.69	.76
60		2¾	1½ 1¾	6 6	34.86	92 92	10000 10000	5.40	.52 .57	.54	.59
70		2¾	1⅜ 1⅝	5½ 6	37.65	84 83	10000 9700	5.	.41	.42 .46	.47
80		2¾	1⅜ 1½	5½ 5½	39.08	78 78	9600 9700	4.70	.34	.35 .36	.38
90		2¾	1⅜ 1⅜	5½ 5½	40.32	74 68	9400 9400	4.50	.29 .27	.30	.33
100		2¾	1⅜ 1⅜	5 5½	42.50	70 68	9400 9400	4.20	.24 .24	.25	.27

Production Table of Ring Filling Yarn.
Front Roll 1 Inch in Diameter.

No. of Yarn.	Size of Spindle.	Gauge of frame.	Diameter of ring.	Length of traverse.	Twist per inch.	Revolutions of front roll per minute.	Revolutions of spindle per minute.	Hanks per spindle per day of 10 hours.	Pounds per spindle per week of 58 hours.	Pounds per spindle per week of 60 hours.	Pounds per spindle per week of 66 hours.
4	Draper No. 2, for all Numbers.	2¾ for all Numbers.	1½ to 1⅝.	7 inches.	6.50	240	5000	10.00	14.40	14.88	16.37
5					7.27	230	5400	10.00	11.50	11.95	13.15
6					7.96	220	5600	9.85	9.53	9.86	10.84
7					8.60	214	5800	9.85	8.13	8.40	9.24
8					9.19	208	6000	9.75	7.07	7.31	8.04
9					9.75	202	6200	9.65	6.24	6.46	7.10
10					10.28	196	6400	9.60	5.56	5.76	6.33
11					10.78	190	6500	9.50	5.00	5.18	5.70
12					11.26	184	6600	9.40	4.54	4.70	5.17
13					11.72	180	6700	9.35	4.15	4.29	4.72
14					12.16	176	6800	9.25	3.82	3.95	4.35
15					12.59	172	6900	9.15	3.53	3.65	4.02
16					13.	168	7000	9.05	3.28	3.39	3.73
17					13.40	166	7100	9.00	3.07	3.17	3.48
18					13.79	162	7200	8.80	2.84	2.93	3.22
19					14.17	158	7200	8.70	2.64	2.74	3.02
20					14.53	156	7300	8.60	2.49	2.58	2.83
21					14.89	154	7300	8.50	2.34	2.42	2.67
22					15.24	152	7400	8.40	2.21	2.29	2.52
23					15.59	150	7400	8.30	2.09	2.16	2.38
24					15.92	148	7600	8.20	1.98	2.05	2.25
25					16.25	146	7600	8.10	1.87	1.94	2.13
26					17.84	144	8000	7.95	1.77	1.83	2.01
27					18.19	142	8200	7.85	1.68	1.74	1.91
28					18.52	140	8200	7.75	1.60	1.66	1.83
29					18.84	138	8300	7.60	1.52	1.57	1.73
30					19.17	136	8300	7.55	1.45	1.51	1.66
31					20.88	134	8800	7.45	1.39	1.44	1.58
32					21.21	132	8800	7.35	1.33	1.38	1.52
33					21.54	130	8900	7.25	1.27	1.31	1.44
34					21.87	128	8900	7.20	1.22	1.27	1.39
35					22.19	126	8900	7.10	1.17	1.21	1.33
36					22.50	124	8900	7.00	1.12	1.16	1.28
37					22.81	122	8800	6.90	1.08	1.11	1.23
38					23.12	120	8800	6.80	1.03	1.07	1.18
39					23.42	118	8800	6.70	.99	1.03	1.13
40					23.72	116	8800	6.65	.96	1.00	1.10
41					24.01	114	8700	6.55	.92	.96	1.06
42					24.30	112	8700	6.40	.88	.91	1.00
43					24.59	110	8600	6.30	.84	.87	.96
44					24.87	108	8600	6.20	.81	.84	.93
45					25.16	106	8500	6.10	.78	.81	.89
46					25.43	104	8500	6.	.75	.78	.86
47					25.71	104	8500	6.	.74	.76	.84
48					25.98	102	8400	5.90	.71	.73	.81
49					26.25	102	8300	5.90	.69	.72	.79
50					26.52	100	8200	5.80	.67	.69	.76
55					27.00	96	8200	5.50	.58	.60	.66
60					27.00	92	8000	5.30	.51	.53	.58
65					27.00	88	7700	5.10	.45	.47	.52
70					27.19	84	7400	4.90	.40	.42	.47
75					28.15	82	7400	4.80	.37	.38	.42
80					29.07	80	7400	4.60	.33	.34	.37
85					29.96	78	7400	4.60	.31	.32	.35
90					31.00	76	7400	4.40	.28	.29	.32
95					31.68	74	7400	4.40	.26	.27	.30
100					32.50	72	7400	4.30	.24	.25	.28

Comparative Production Table of Ring Filling Yarn.

No. of Yarn.	Size of spindle.	Gauge of frame.	Diameter of ring.	Length of traverse.	Twist per inch.	Revolutions of front roll per minute.	Revolutions of spindle per minute.	Hanks per spindle per day of 10 hours.	Pounds per spindle per week of 58 hours.	Pounds per spindle per week of 60 hours.	Pounds per spindle per week of 66 hours.
6		2¾	1⅝	7	7.96	220	5600	9.85	9.53	9.86	10.84
			1½	6½		240	5600		10.20		
8		2¾	1⅝	7	9.19	208	6000	9.75	7.07	7.31	8.04
			1⅝	6½		204	5600			7.30	
10		2¾	1⅝	7	10.28	196	6400	9.60	5.56	5.76	6.33
			1½	7		190	6250		5.		
12		2¾	1⅝	7	11.26	184	6600	9.40	4.54	4.70	5.17
			1½	7		184	6650		4.60		
			1⅝	7		185	6800				4.75
14		2¾	1⅝	7	12.16	176	6800	9.25	3.82	3.95	4.35
			1½	7		160	6400		3.75		
			1 7/16	6		170					4.07
16		2¾	1½	6½	.13	168	7000	9.05	3.28	3.39	3.73
			1½	6½		166	6700				4.08
18		2¾	1½	6½	13.79	162	7200	8.80	2.84	2.93	3.22
			1⅜	5½			7600			2.90	
20		2¾	1¼	6½	14.53	156	7300	8.60	2.49	2.58	2.83
			1 7/16	6		154	7200				3.10
22		2¾	1½	6½	15.24	152	7400	8.40	2.21	2.29	2.52
			1 5/16	5½		172	8330		2.90		
24		2¾	1½	6½	15.92	148	7600	8.20	1.98	2.05	2.25
			1¾	7		156	7800				2.48
25		2¾	1½	6	16.25	146	7600	8.10	1.87	1.94	2.13
			1 7/16	6		148	7650			2.10	
						156			1.91		
26	No. 2.	2¾	1⅜	6	17.84	144	8000	7.95	1.77	1.83	2.01
			1 1/16	6		140	7600				2.00
			1⅜	6¼		142	9100			1.80	
34		2¾	1⅜	6	21.87	128	8900	7.20	1.22	1.27	1.39
			1¼	6½		128	9000			1.28	
36		2¾	1⅜	5½	22.50	124	8900	7.00	1.12	1.16	1.28
			1¼	5½		124	8800		1.12		
			1¼	6¼		132	9500			1.23	
38		2¾	1⅜	5½	23.12	120	8800	6.80	1.03	1.07	1.18
			1⅜	6		122	8800				1.35
40		2¾	1⅜	5½	23.72	116	8800	6.65	.96	1.00	1.10
			1⅜	6		110	8700		.94		
			1⅜	5½		118	9500				1.10
42		2¾	1¼	5½	24.30	112	8700	6.40	.88	.91	1.00
			1¼	5½		114	9000		.80		
			1¼	6		129	9000		1.07		
44		2¾	1¼	5½	24.87	108	8600	6.20	.81	.84	.93
			1¼	5½		103	8200		.81		
48		2¾	1¼	5½	25.98	102	8400	5.90	.71	.73	.81
			1¼	5½		103	8200		.74		
50		2¾	1¼	5½	26.52	100	8200	5.80	.67	.69	.76
			1⅜	5½			8400		.74		
60		2¾	1¼	5	27.	92	8000	5.30	.51	.53	.58
			1⅜	6½		88	7300				
70		2¾	1¼	5	27.19	84	7400	4.90	.40	.42	.47
						72	7200		.34		
			1⅜	5¾		98	8000		.49		

Table of Constants.

Number of yarn.	Revolutions of front roll recommended by our warp table.	Constant for warp for 58 hours production in pounds.	Constant for warp for 60 hours production in pounds.	Constant for warp for 66 hours production in pounds.		Revolutions of front roll recommended by our filling table.	Constant for filling for 58 hours production in pounds.	Constant for filling for 60 hours production in pounds.	Constant for filling for 66 hours production in pounds.
4	204	.298	.308	.338		240	.240	.248	.273
5	200	.302	.312	.343		236	.250	.258	.284
6	196	.305	.315	.346		220	.260	.268	.295
7	192	.308	.318	.350		214	.266	.275	.302
8	188	.311	.321	.353		208	.272	.281	.309
9	184	.315	.326	.357		202	.278	.287	.316
10	180					196	.284	.293	.323
11	176	.316	.326	.359		190	.290	.300	.330
12	172					184	.296	.306	.337
13	168	.317	.328	.360		180	.300	.310	.341
14	164	.318	.328	.361		176	.304	.314	.346
15	160					172	.308	.318	.350
16	156	.319	.329	.362		168	.312	.322	.355
17	152	.320	.330	.363		166	.314	.324	.357
18	148	.321	.331	.364		162	.316	.326	.359
19	144	.322	.333	.365		158	.318	.328	.361
20	140					156	.320	.330	.363
21	138	.323	.334	.367		154			
22	136	.324	.335	.368		152			
23	134					150			
24	132					148			
25	130	.325	.336	.369		146			
26	128					144			
27	126					142			
28	124	.328	.339	.373		140			
29	122					138			
30	120					136			
31	120					134	.321	.331	.364
32	118					132	.322	.333	.365
33	118					130	.323	.334	.367
34	116					128	.324	.335	.368
35	116	.329	.340	.374		126	.325	.336	.369
36	114					124	.326	.337	.370
37	114					122	.327	.338	.371
38	112					120	.328	.339	.373
39	112					118	.329	.340	.374
40	110	.330	.341	.375		116	.330	.341	.375
41	110					114			
42	108	.331	.342	.376		112	.331	.342	.376
43	108					110			
44	106	.332	.343	.377		108	.332	.343	.377
45	106					106			
46	104	.333	.334	.378		104	.333	.344	.378
47	104					104			
48	102	.334	.345	.379		102	.334	.345	.379
49	102					102			
50	100	.335	.346	.380		100	.335	.346	.380
55	96	.337	.349	.383		96			
60	92	.339	.350	.385		92			
65	88	.341	.352	.387		88			
70	84	.343	.354	.390		84			
75	80					82			
80	78					80			
85	76					78			
90	74					76			
95	72					74			
100	70					72			

SPINNING FRAME DIMENSIONS.

American frames are built in regular widths of 36, 39 and 42 inches. The length varies slightly in different makes of frame, so that these figures must not be relied on as absolute for all builds. They are merely intended to give a fair idea for approximate figuring.

NUMBER OF SPINDLES.	2½ IN. GAUGE.		2⅝ IN. GAUGE.		2¾ IN. GAUGE.	
	FT.	IN.	FT.	IN.	FT.	IN.
112	13	10	14	5	14	12
128	15	6	16	2	16	10
144	17	2	17	11	18	8
160	18	10	19	8	20	6
176	20	6	21	5	22	4
192	22	2	23	2	24	2
208	23	10	24	11	26	
224	25	6	26	8	27	10
240	27	2	28	5	29	8
256	28	10	30	2	31	6
272	30	6	31	11	33	4
288	32	2	33	8	35	2
304	33	10	35	5	37	
320	35	6	37	2	38	10
336	37	2	38	11	40	8

NUMBER OF SPINDLES.	3 IN. GAUGE.		3¼ IN. GAUGE.		3½ IN. GAUGE.	
	FT.	IN.	FT.	IN.	FT.	IN.
120	17	2	18	5	19	8
132	18	8	20	½	21	5
144	20	2	21	8	23	2
156	21	8	23	3½	24	11
168	23	2	24	11	26	8
180	24	8	26	6½	28	5
192	26	2	28	2	30	2
204	27	8	29	9½	31	11
216	29	2	31	5	33	8
228	30	8	33	½	35	5
240	32	2	34	8	37	2
252	33	8	36	3½	38	11
264	35	2	37	11	40	8
276	36	8	39	6½	42	5

The above lengths of frames over all are figured with tight and loose pulleys of 2½ inch face. If 3 inch face pulleys are figured, add 1 inch to the above lengths.

WEIGHT OF TEN TRAVELERS IN GRAINS.

Number.	Weight Grains.	Number.	Weight Grains.
23-0	1	8	21
22-0	1¼	9	23
21-0	1½	10	25
20-0	1¾	11	27
19-0	2	12	29
18-0	2¼	13	31
17-0	2½	14	33
16-0	2¾	15	35
15-0	3	16	37
14-0	3¼	17	39
13-0	3½	18	41
12-0	3¾	19	43
11-0	4	20	45
10-0	4½	21	47
9-0	5	22	49
8-0	5½	23	51
7-0	6	24	53
6-0	6½	25	55
5-0	7	26	58
4-0	7½	27	61
3-0	8	28	64
2-0	8½	29	67
1-0	9	30	70
1	10	31	75
2	11	32	80
3	12	33	85
4	13	34	90
5	15	35	95
6	17	36	100
7	19	37	105

ARTIFICIAL HUMIDIFICATION.

The humidification of a cotton mill is mainly artificial in character, and is closely associated with other conditions of the atmosphere which should be considered with relation to it. The necessity for artificial humidification arises: First, because of loss of weight in the cotton or cloth if the air is too dry and the natural amount of moisture not present. Second, because of trouble in the card room with electricity unless there is a suitable amount of moisture in the air. Third, because the moisture favorably affects the grip of the cotton fibers on each other, making less breakage of ends both in the spinning and weaving rooms, and less loss of fiber in the form of invisible waste. Fourth, because of the freshening and cooling effect, under certain possible applications, making the air more agreeable to the operatives at certain temperatures.

Considering the matter first from the standpoint of getting cheap product, it is possible that the principal advantage in artificial humidification is in getting more product from the operative because of the beneficial physical effect of a suitable atmosphere, and the lessening of labor required on the machinery. The human system is fed by oxygen in the air. A room might be well moistened, yet poorly ventilated. Proper systems of humidification cleanse and cool the air and absorb a certain amount of soluble gases. To replace the waste of oxygen new air must be supplied. If ventilaton is not continuous by means of the methods in use, the rooms should be properly ventilated before running hours and the fresh air properly humidified before the help come in.

The same percentage of humidity, or the "relative humidity," as it is known, does not necessarily produce the same physical result at all temperatures. A definite percentage of humidity at one temperature might make the conditions very disagreeable to the operative at another temperature. The English Factory Laws, for instance, allow a relative humidity of 88 per cent. at 60 degrees of the dry bulb, but only 64 per cent. at 100 degrees. The 75 per cent. which some accept as a general standard, is only authorized by the Cotton Factory Act, at a dry bulb temperature of less than 82 degrees. It is generally understood that the operatives would prefer a temperature of between 70 degrees and 76 degrees of the dry bulb, but it is not always possible to regulate the temperature as desired in hot weather. The use of extra humidification to cool the air in hot weather often produces a higher percentage of humidity than is recommended in any standard table. The cooling effect lessens as the humidity increases. It must be understood, of

course, that careful attention to proper humidification is impossible unless good thermometers are used, and unless the wet bulb is properly moistened, and used with clean wicking. The wet bulb thermometer should be at sufficient distance from the dry bulb so that the moisture in the wick, or the water holder, will not affect it. Wet and dry bulb thermometers simply give the conditions of the atmosphere in their immediate vicinity. In large rooms it is necessary to have several sets of apparatus. By having several sets, errors can be readily found by hanging them in pairs to note whether they register alike. A uniform standard of humidification assists the operation of such machinery as relies for its regularity of operation upon climatic conditions. Looms have a delicate adjustment of pick which is considerably modified by moisture. Cards are affected by electricity when the air is dry. Spinning frames vary their band tension as the humidification changes, etc., etc.

While we give tables of relative and actual humidity, the average mill man merely wants to know how low his wet bulb thermometer should read by comparison with the dry bulb. We have tried to submit a table of humidity recommendation in simple, usable form, for mill managers, without fractions or decimals. We have found that the recommendations from experience do not require this table to be absolutely scientific in progression or proportion, and we would not assume that it is possible to definitely standardize an art in which the experience of test is not yet complete. We would welcome any information from practical experience in mills using this or any other standard, to form a basis of future correction if such correction is found necessary.

While our table is not absolutely like any other yet printed, it varies but slightly from those adopted by the leading introducers of humidifying apparatus, the weave room standard being similar to the limits allowed by the English Cotton Factory Act used by the American Moistening Company, and the first two tables vary little from those recently published for use with the Cramer Automatic Regulator.

The card room table is arranged to give a lower humidity than we advised when this table was first printed in our "Cotton Chats" in view of further investigation and advice on the matter.

(We acknowledge indebtedness for assistance and suggestion in the preparation of these recommendations, to both the American Moistening Company and Mr. Stuart W. Cramer.)

DRAPER TABLE OF RECOMMENDED HUMIDITY

For Cotton Mill Conditions.

DRY BULB.	WEAVE ROOM.	SPINNING ROOM.	CARD ROOM.
	WET BULB.	WET BULB.	WET BULB.
60	58	56	52
61	59	57	53
62	60	58	54
63	61	59	55
64			
65	62	60	56
66	63	61	57
67	64	62	58
68	65	63	59
69	66	64	60
70			
71	67	65	61
72	68	66	62
73	69	67	63
74	70	68	64
75	71	69	65
76	72	70	66
77	73	71	67
78			
79	74	72	68
80	75	73	69
81	76	74	70
82			71
83	77	75	72
84	78	76	73
85	79	77	74
86			
87	80	78	75
88	81	79	76
89	82	80	77
90			
91	83	81	78
92	84	82	79
93	85	83	80
94			81
95	86	84	82
96	87	85	83
97	88	86	84
98			
99	89	87	85
100	90	88	86

We print this table on a stiff card for convenience of mill superintendents and overseers. Samples furnished on application.

RELATIVE AND ACTUAL HUMIDITY.

In our catalogue of 1887, we printed tables of relative and actual humidity like those in use by the United States Signal Service and have reproduced them in later issues. These tables, however, are not prepared by use of the ordinary wet and dry bulb thermometers, and vary slightly from the English tables of Glaisher, which are based on wet and dry bulb thermometers similar to those in ordinary use. The Glaisher tables are based on a barometric pressure of 29 inches, and since they are used by the leading introducers of air moistening machinery, we prefer to follow them, under the present conditions. In order to condense and eliminate unnecessary figures we only give such readings as are thought necessary for the conditions in Cotton Mills.

Reading of Thermometer.		Degree of Humidity.	Vapor in a Cubic foot of Air.	Reading of Thermometer.		Degree of Humidity.	Vapor in a Cubic foot of Air.	Reading of Thermometer.		Degree of Humidity.	Vapor in a Cubic foot of Air.	Reading of Thermometer.		Degree of Humidity.	Vapor in a Cubic foot of Air.
Dry.	Wet.			Dry.	Wet.			Dry.	Wet.			Dry.	Wet.		
60	60	100	5.8	**65**	65	100	6.8	**70**	70	100	8.	**75**	75	100	9.4
	59	94	5.4		64	94	6.4		69	94	7.5		74	94	8.9
	58	88	5.1		63	88	6.		68	88	7.1		73	89	8.4
	57	82	4.7		62	83	5.6		67	83	6.7		72	84	7.9
	56	76	4.4		61	78	5.3		66	78	6.3		71	79	7.4
	55	71	4.1		60	73	4.9		65	73	5.9		70	74	7.
	54	66	3.8		59	68	4.6		64	69	5.5		69	70	6.6
	53	62	3.6		58	63	4.3		63	65	5.2		68	66	6.2
	52	58	3.3		57	59	4.		62	61	4.9		67	62	5.8
	51	54	3.1		56	55	3.8		61	57	4.6		66	58	5.5
	50	50	2.9		55	51	3.5		60	53	4.3		65	55	5.2
	49	46	2.7		54	48	3.3		59	50	4.		64	52	4.9
61	61	100	6.	**66**	66	100	7.	**71**	71	100	8.3	**76**	76	100	9.7
	60	94	5.6		65	94	6.6		70	94	7.8		75	94	9.2
	59	88	5.2		64	88	6.2		69	88	7.3		74	89	8.6
	58	82	4.9		63	83	5.8		68	83	6.9		73	84	8.2
	57	77	4.6		62	78	5.5		67	78	6.5		72	79	7.7
	56	72	4.3		61	73	5.1		66	73	6.1		71	75	7.2
	55	67	4.		60	68	4.8		65	69	5.7		70	71	6.8
	54	62	3.7		59	64	4.5		64	65	5.4		69	67	6.4
	53	58	3.5		58	60	4.2		63	61	5.1		68	63	6.1
	52	54	3.2		57	56	3.9		62	57	4.7		67	59	5.7
	51	50	3.		56	52	3.7		61	53	4.4		66	55	5.4
	50	47	2.8		55	48	3.4		60	50	4.2		65	52	5.1
62	62	100	6.2	**67**	67	100	7.3	**72**	72	100	8.5	**77**	77	100	10.
	61	94	5.8		66	94	6.8		71	94	8.		76	94	9.5
	60	88	5.4		65	88	6.4		70	89	7.6		75	89	8.9
	59	82	5.1		64	83	6.		69	84	7.1		74	84	8.4
	58	77	4.7		63	78	5.6		68	79	6.7		73	79	8.
	57	72	4.4		62	73	5.3		67	74	6.3		72	75	7.5
	56	67	4.1		61	68	5.		66	69	5.9		71	71	7.1
	55	62	3.9		60	64	4.7		65	65	5.6		70	67	6.7
	54	58	3.6		59	60	4.4		64	61	5.3		69	63	6.3
	53	54	3.4		58	56	4.1		63	57	5.		68	59	5.9
	52	50	3.1		57	52	3.8		62	54	4.7		67	56	5.6
	51	47	2.9		56	49	3.6		61	51	4.4		66	53	5.3
63	63	100	6.4	**68**	68	100	7.5	**73**	73	100	8.8	**78**	78	100	10.3
	62	94	6.		67	94	7.1		72	94	8.3		77	94	9.7
	61	88	5.6		66	88	6.6		71	89	7.6		76	89	9.2
	60	82	5.2		65	83	6.2		70	84	7.4		75	84	8.7
	59	77	4.9		64	78	5.8		69	79	7.0		74	79	8.2
	58	72	4.6		63	73	5.5		68	74	6.6		73	75	7.8
	57	67	4.3		62	68	5.2		67	70	6.2		72	71	7.3
	56	63	4.		61	64	4.8		66	66	5.8		71	67	6.9
	55	59	3.7		60	60	4.5		65	62	5.4		70	63	6.5
	54	55	3.5		59	56	4.2		64	58	5.1		69	59	6.2
	53	51	3.3		58	52	4.		63	54	4.8		68	56	5.8
	52	47	3.		57	49	3.7		62	51	4.5		67	53	5.5
64	64	100	6.6	**69**	69	100	7.8	**74**	74	100	9.1	**79**	79	100	10.6
	63	94	6.2		68	94	7.3		73	94	8.6		78	95	10.1
	62	88	5.8		67	88	6.9		72	89	8.1		77	90	9.5
	61	82	5.4		66	83	6.5		71	84	7.6		76	85	9.
	60	77	5.1		65	78	6.1		70	79	7.2		75	80	8.5
	59	72	4.8		64	73	5.7		69	74	6.8		74	75	8.
	58	67	4.5		63	68	5.3		68	70	6.4		73	71	7.6
	57	63	4.2		62	64	5.		67	66	6.		72	67	7.2
	56	59	3.9		61	60	4.7		66	62	5.6		71	63	6.8
	55	55	3.6		60	56	4.4		65	58	5.3		70	59	6.4
	54	51	3.4		59	53	4.1		64	55	5.		69	56	6.
	53	48	3.2		58	50	3.9		63	52	4.7		68	53	5.6

Reading of Thermometer.		Degree of Humidity.	Vapor in a Cubic foot of Air.	Reading of Thermometer.		Degree of Humidity.	Vapor in a Cubic foot of Air.	Reading of Thermometer.		Degree of Humidity.	Vapor in a Cubic foot of Air.	Reading of Thermometer.		Degree of Humidity.	Vapor in a Cubic foot of Air.
Dry.	Wet.			Dry.	Wet.			Dry.	Wet.			Dry.	Wet.		
80	80	100	11.	**85**	85	100	12.8	**90**	90	100	14.8	**95**	95	100	17.2
	79	95	10.4												
	78	90	9.8		81	80	10.3		85	77	11.4		90	78	13.4
	77	85	9.3		80	76	9.7		84	73	10.8		89	74	12.7
	76	80	8.8		79	72	9.2		83	69	10.3		88	70	12.1
	75	75	8.3		78	68	8.7		82	65	9.7		87	66	11.5
	74	71	7.8		77	64	8.3		81	62	9.2		86	63	10.9
	73	67	7.4		76	61	7.8		80	59	8.7		85	60	10.3
	72	63	7.0		75	58	7.4		79	56	8.3		84	57	9.8
	71	59	6.6		74	55	7.		78	53	7.8		83	54	9.3
	70	56	6.2		73	52	6.6		77	50	7.4		82	51	8.8
	69	53	5.8		72	49	6.2		76	47	7.0		81	48	8.3
81	81	100	11.3	**86**	86	100	13.2	**91**	91	100	15.3	**96**	96	100	17.7
	80	95	10.7												
	79	90	10.1		82	80	10.6		86	78	11.8		91	78	13.8
	78	85	9.5		81	76	10.1		85	74	11.2		90	74	13.1
	77	80	9.1		80	72	9.5		84	70	10.6		89	70	12.4
	76	76	8.6		79	68	9.		83	66	10.1		88	66	11.8
	75	72	8.1		78	64	8.5		82	62	9.5		87	63	11.2
	74	68	7.6		77	61	8.1		81	59	9.		86	60	10.7
	73	64	7.2		76	58	7.6		80	56	8.5		85	57	10.1
	72	60	6.8		75	55	7.2		79	53	8.1		84	54	9.6
	71	56	6.4		74	52	6.8		78	50	7.7		83	52	9.1
	70	53	6.0		73	49	6.4		77	47	7.2		82	49	8.6
82	82	100	11.7	**87**	87	100	13.6	**92**	92	100	15.7	**97**	97	100	18.2
	81	95	11.1												
	80	90	10.5		83	81	11.		87	77	12.2		92	78	14.2
	79	85	9.9		82	77	10.4		86	73	11.6		91	74	13.5
	78	80	9.4		81	73	9.8		85	70	11.		90	70	12.8
	77	76	8.9		80	69	9.3		84	66	10.4		89	67	12.2
	76	72	8.4		79	65	8.8		83	62	9.9		88	64	11.6
	75	68	7.9		78	61	8.3		82	59	9.3		87	60	11.
	74	64	7.5		77	58	7.9		81	56	8.8		86	57	10.4
	73	60	7.1		76	55	7.4		80	53	8.3		85	54	9.9
	72	57	6.7		75	52	7.		79	50	7.9		84	52	9.4
	71	54	6.3		74	49	6.6		78	47	7.5		83	49	8.9
83	83	100	12.	**88**	88	100	14.	**93**	93	100	16.2	**98**	98	100	18.7
	82	95	11.7												
	81	90	10.8		84	81	11.4		88	78	12.6		93	78	14.6
	80	85	10.2		83	77	10.8		87	74	11.9		92	74	13.9
	79	80	9.7		82	73	10.2		86	70	11.3		91	70	13.2
	78	76	9.1		81	69	9.6		85	66	10.7		90	67	12.6
	77	72	8.6		80	65	9.1		84	63	10.2		89	64	12.
	76	68	8.2		79	61	8.6		83	60	9.6		88	61	11.4
	75	64	7.7		78	58	8.1		82	57	9.1		87	58	10.8
	74	60	7.3		77	55	7.7		81	54	8.7		86	55	10.2
	73	57	6.9		76	52	7.3		80	51	8.2		85	52	9.7
	72	54	6.5		75	49	6.9		79	48	7.8		84	49	9.2
84	84	100	12.4	**89**	89	100	14.4	**94**	94	100	16.7	**99**	99	100	19.3
	83	95	11.7												
	82	90	11.1		85	81	11.7		89	78	13.		94	79	15.1
	81	85	10.5		84	77	11.1		88	74	12.3		93	75	14.4
	80	80	10.		83	73	10.5		87	70	11.7		92	71	13.7
	79	76	9.4		82	69	10.		86	66	11.1		91	67	13.
	78	72	8.9		81	65	9.4		85	63	10.5		90	64	12.3
	77	68	8.5		80	61	8.9		84	60	10.		89	61	11.7
	76	64	8.		79	58	8.4		83	57	9.5		88	58	11.1
	75	60	7.5		78	55	8.		82	54	9.		87	55	10.5
	74	57	7.1		77	52	7.5		81	51	8.5		86	52	10.
	73	54	6.7		76	49	7.1		80	48	8.		85	49	9.5

BREAKING STRENGTH OF YARN.

In 1886 we prepared a breaking strength table after testing samples from 225 representative mills. We print it alongside our new table for comparison.

With the change in conditions a new standard seems necessary, and this 20th year seems a good time in which to introduce it. In 1886 there were very few combers in use in this country, and a large proportion of the yarn was made from single roving with old-fashioned top flat cards, smaller rings and lower speeds than are now used. Some of these conditions would seem to favor the quality of the yarn, but to offset them we have a higher general skill in management, improved machinery and better knowledge of how to get good results from the machines.

In American mills, the breaking strength is ascertained by use of a strength tester operated by hand or power, which handles a skein made with 80 revolutions of a reel a yard and a half in circumference. As the skein is in the form of a loop, the machine really tests the strength of 160 strands of yarn. This number is arranged so that the result in pounds will read just ten times the result in ounces by testing single yarn strands with a single thread tester; for, if we take the result in ounces and divide by 16 to get the quotient in pounds, we arrive at the same figures as when dividing the record of the skein tester by 160 to get the single thread quotient. Breaking strength is usually taken by reeling skeins from at least four bobbins and averaging the results from all after breaking one or more skeins from each bobbin. In such a system it is evident that the average result produced by no means shows the variation in single yarns. This fact is emphasized when the same yarn is tested by a single thread tester. It must be remembered that the machine for testing the breaking strength of skeins cannot give the actual average strength of the yarn, for it is impossible to get the tension on all the 160 separate yarn sections equal. A few strands break first, bringing the whole strain on a lesser number. The error is fairly constant, so that the machine is perfectly proper for comparative purposes. The hand driven tester, however, is not suitable for accurate comparisons, for the operator cannot give a steady motion to the wheel under a continually increasing strain. We have seen the same yarn show wide comparative differences when tested on a hand breaker and a power breaker. Owing to the steadier strain, the yarn breaks stronger with a power-driven tester; and it must be remembered that our table is made up from results so obtained. Ours is a Brown Bros. tester run at a speed of 190 revolutions

per minute. We are glad at any time to test the yarn for any of the mills which have no power driven tester so that they may see how nearly their yarn comes to our table when tested under similar conditions. Those whose yarn does not break as well as our table when tested with a hand tester need not necessarily assume that their yarn is inferior. The single-thread testers are interesting to show the variation in single yarns, but they are useless for comparative purposes unless the tests are continued to a tiresome extent. A single-thread tester gives higher results than a skein tester as a general rule. We have found it to vary from 15 to 20 per cent. The variation in single yarns is naturally much greater than in skeins, since the breaking of many strands together necessarily trends toward uniformity. We have found yarn that broke in skeins from 46 to 54 pounds, show from 4 to 7 ounces on a single-thread tester, which is equivalent to 40 to 70 pounds on the skein. Skeins showing from 105 to 128 pounds on the skein tester, varied from 12 ounces to 20 ounces, or from 120 to 200 pounds on the single-thread tester. Yarn showing 152 to 208 pounds on skein tests, varied from 16 ounces to 23½ ounces on single-thread test, or equivalent to 160 to 235 for skein test.

Variations in strength of yarn are due, in part, to variations in size, but they do not necessarily follow the variations in size with uniformity. Yarn is made weak by lack of twist, and also made weak by excessive twist. Different bobbins from the same frame will vary on account of differences in rolls, rings, travellers, ring setting, etc. It is not safe to draw conclusions from single tests or single lots. Variations in size or number are important since a variation from standard may give the mill's customer less or more product than demanded. Variation in yarn is evidence of improper selection of processes, or improper running of the machinery in the preparatory department. No one has ever yet definitely settled by extensive comparative tests the best and most economical method of preparing for strong, even yarn. There are still those who claim that a multiplicity of doublings and drawings weakens the yarn, and it is not definitely proved just where the doublings should be made. It is possible that we may some day find that a proper doubling and evening of the sliver at some particular stage of manufacture will allow less processes, or less doublings, in other stages.

There is a general impression to the effect that yarn wound from a full bobbin is stronger than that wound off nearer the bare bobbin. We have gone into exhaustive tests to determine whether this theory is correct, and find that while there is no uniformity, the yarn first spun often breaks stronger while actually finer in number. In one test we tested all the yarn on

four bobbins of yarn made from Middling cotton, single carding, twist 24.40, spun with 1⅞ inch ring, 6½ inches traverse. There were 17 skeins of yarn on each bobbin, making 68 skeins tested in all. The yarn averaged in number 15.82 and the breaking strength averaged 109. The weakest skein broke 95 pounds and the strongest 125. The number of yarn varied from 14.93 to 17.33. The first 16 skeins averaged in number 15.55, breaking an average of 106. The last sixteen skeins averaged in number 16.03, breaking 113.6.

To show the difference between yarn tested under different conditions of humidity, we took four bobbins of yarn made from Good Middling cotton grown in South Carolina, single carding, 28.45 twist, spun on 1¾ inch ring, 6½ inches traverse, dry bulb showed 71, wet bulb 66. The average breaking strength was 60 pounds per skein, while the average number of the yarn was 29. We then kept this yarn 24 hours in a dry kiln with a temperature of 120 degrees for that period. The average breaking strength was now 55 pounds, while the average number was 29.78. Next, we soaked the yarn five minutes under water, merely drying off the outside with a towel. It then showed 64 pounds breaking strength, average number 28.70. We next soaked the yarn 40 hours under water and it broke 66.50, average number of yarn 26.13. Of course, the variation in the yarn numbering came from the additional weight of the water absorbed. This would show the extremes of dryness and wetness to be about 10 per cent. below or above the standard.

The warp yarn tested for the tables was mostly single carded on revolving flat cards, and averaged about Strict Middling in grade. The combed yarn tests were made from the American yarn sent in, which averaged slightly under Good Middling in grade. The soft-twisted yarn was of various kinds and used for various purposes. In these tests the stronger twisted filling was eliminated. The average twist of the yarn tested was very close to 3.25 times the square root of the number. The grade of the cotton averaged about Strict Middling.

The most surprising thing about the tests was the strength of the soft twisted yarn in the coarser numbers, this running at times higher than our old standard for warp.

Owing to delay in arrival of yarn and in getting proper machinery for testing, the yarn tested probably averaged an aging of at least six months. It was kept in our weave room during this time under fairly uniform conditions of humidity. At the time of the tests the humidity in the weave room averaged quite closely to the humidity standard which we recommend for the spinning room. Certain mills made much more even yarn than others on the same numbers. It was noticed that the combed yarn varied considerably in number. There

was not enough yarn supplied to make a comparative test of Combed Egyptian, Sea Island and American cotton. Sea Island and Fancy Georgia cottons naturally broke stronger than the ordinary American grades, and also better than the Egyptian grades. No attempt was made to classify according to length of staple. It must be remembered that these tables represent an **average** breaking strength, although it is natural that our samples should largely come from the mills that are making the better yarns.

As the yarn numbers vary constantly, and as the twist in different classes of yarn is also fairly constant, the curve plotted from the breaking strengths should also be a constant curve. The purpose of testing the hundreds of sample yarns sent has been to find out by the actual results just what constant curve will most uniformly meet the actual conditions. The results given in the tables are taken from constant curves without giving the decimals, as the strength tester cannot be read to decimal results. Anyone wishing to make a very careful or scientific comparison of yarns should accurately compute the result to decimals, using the following rules.

STANDARD WARP YARN.

Weigh the skein after breaking and divide weight into 1000 to get number of yarn (or use tables in our book or the table printed on one sheet which we supply) then add this to 1900 and divide by the number. Example: Skein weighs 45.3 grains. Divided into 1000 gives 22.08 the number of the yarn. $1900 + 22.08 = 1922.08 \div 22.08 = 87.05$ which is the standard breaking weight for this number.

If several skeins are broken the average weight can be used.

For combed warp yarn the standard is obtained by multiplying the number by four, subtracting from 2600 and dividing the quotient by the number.

For soft twist yarn the standard is obtained by multiplying the number by 13, subtracting from 1900 and dividing the quotient by the number.

Our tables do not give figures for carded warp or soft twist above number 50. They can be easily figured if required. The + and — signs signify decimals. For instance 62.30 would be given as 62+ while 62.70 would be given as 63— . 31.51 would be given as 32— while 31.50 would be given as 31+ .

DRAPER TABLES

OF

BREAKING WEIGHTS OF AMERICAN YARNS

SPUN FROM AMERICAN COTTON.

AVERAGED FROM SAMPLE SKEIN TESTS FROM SEVERAL HUNDRED AMERICAN MILLS.

120 yards Weight in Grains.	Number of Yarn.	OLD Breaking Weight of Warp Yarn.	NEW Breaking Weight of Warp Yarn.	NEW Breaking Weight Combed Warp.	NEW Breaking Weight Soft Twist Yarn.	120 yards Weight in Grains.	Number of Yarn.	OLD Breaking Weight of Warp Yarn.	NEW Breaking Weight Combed Warp.
1000	1					19.6	51	36.6	47—
500	2					19.2	52	36.1	46
333.3	3	530	634+	863—	620+	18.9	53	35.5	45+
250	4	410	476—	646	462	18.5	54	34.9	44+
200	5	330	381	516	367	18.2	55	34.4	43+
166.7	6	275	318—	429+	304—	17.9	56	33.8	42+
142.9	7	237.6	272+	367+	258+	17.5	57	33.4	42—
125	8	209	238+	321	224+	17.2	58	32.8	41—
111.1	9	186.5	212+	285—	198+	17	59	32.3	40+
100	**10**	168.7	191	256	177	16.7	**60**	31.7	39+
90.9	11	154.1	174—	232+	160—	16.4	61	31.3	39—
83.3	12	142	159+	213—	145+	16.1	62	30.8	38—
76.9	13	131.5	147+	196	133+	15.9	63	30.4	37+
71.4	14	122.8	137—	182—	123—	15.6	64	30	37—
66.7	15	115.1	128—	169+	114—	15.4	65	29.6	36
62.5	16	108.4	120—	158+	106—	15.2	66	29.2	35+
58.8	17	102.5	113—	149—	99—	14.9	67	28.8	35—
55.6	18	97.3	107—	140+	93—	14.7	68	28.5	34+
52.6	19	92.6	101	133—	87	14.5	69	28.2	34—
50	**20**	88.3	96	126	82	14.3	**70**	27.8	33+
47.6	21	83.8	91+	120—	77+	14.1	71	27.4	33—
45.5	22	79.7	87+	114+	73+	13.9	72	27.1	32+
43.5	23	75.9	84—	109+	70—	13.7	73	26.8	32—
41.7	24	72.4	80+	104+	66+	13.5	74	26.5	31+
40	25	69.2	77	100	63	13.3	75	26.2	31—
38.5	26	66.3	74+	96	60+	13.2	76	25.8	30+
37	27	63.6	71+	92+	57+	13	77	25.5	30—
35.7	28	61.3	69—	89—	55—	12.8	78	25.3	29+
34.5	29	59.2	67—	86—	53—	12.7	79	24.9	29—
33.3	**30**	57.3	64+	83—	50+	12.5	**80**	24.6	28+
32.3	31	55.6	62+	80—	48+	12.4	81	24.3	28+
31.3	32	54	60+	77+	46+	12.2	82	24	28—
30.3	33	52.6	59—	75—	45—	12.1	83	23.7	27+
29.4	34	51.2	57—	72+	43—	11.9	84	23.4	27—
28.6	35	50	55+	70+	41+	11.8	85	23.2	27—
27.8	36	48.7	54—	68+	40—	11.6	86	22.8	26+
27	37	47.6	52+	66+	38+	11.5	87	22.6	26—
26.3	38	46.5	51	64+	37	11.4	88	22.4	26—
25.6	39	45.5	50—	63—	36—	11.2	89	22.2	25+
25	**40**	44.6	48+	61	34+	11.1	**90**	22	25—
24.4	41	43.8	47+	59+	33+	11	91	21.7	25—
23.8	42	43	46+	58—	32+	10.9	92	21.5	24+
23.3	43	42.2	45+	56+	31+	10.8	93	21.3	24—
22.7	44	41.4	44+	55+	30+	10.6	94	21.2	24—
22.2	45	40.7	43+	54—	29+	10.5	95	21	23+
21.7	46	40	42+	53—	28+	10.4	96	20.7	23+
21.3	47	39.3	41+	51+	27+	10.3	97	20.5	23—
20.8	48	38.6	41—	50+	27—	10.2	98	20.4	23—
20.4	49	37.9	40—	49+	26—	10.1	99	20.2	22+
20	**50**	37.3	39	48	25	10	**100**	20	22

RULES FOR SPINNERS.

To find the draught of a spinning frame:—

Write down the number of teeth in all the driving-wheels, and multiply them together. Then write down the number of teeth in all the wheels that are driven, and multiply them together in like manner. If there is any difference in the diameter of the rollers, multiply the least, or driver's product, by the diameter of the back roller; and the largest product, or that of the driven wheels, by the diameter of the front roller. Divide the product of the driven wheels by that of the drivers, and the quotient will be the draught of the machine.

To change the draught-gear on a spinning-frame when changing to a different number of yarn and the draught and roving have both to be altered:—

Multiply the number of yarn being spun, by the hank roving desired, and that product by the number of teeth in the change pinion being used; divide the product thus obtained by the number of yarn desired, multiplied by the hank roving being used. The quotient will show the change pinion required.

To change the draught gear when changing from one number of yarn to another without changing the roving:—

Multiply the number of teeth in the change pinion in use by the number of yarn spun. This product divided by the number of yarn desired will give the change pinion required.

To change the twist-gear when changing to a different number of yarn:—

Square the number of teeth in the present gear, and multiply by the number of yarn being spun. Divide this product by the number of the yarn desired; the square root of the quotient will show the proper number of teeth for the new gear.

To find what per cent. yarn contracts in twisting:—

Divide the number of the yarn by the product of the draught and hank roving, and subtract the quotient from 1. *Example*: Suppose No. 28.5 yarn is being spun from 4-hank roving, with a draught of 7.26. $7.26 \times 4 = 29.04$. $28.5 \div 29.4 = 0.98$, which subtracted from 1.00 leaves .02, or two per cent=the contraction in length.

To find the loss of twist in spinning:—

By the "loss of twist" is meant the amount the actual twist is less than that found by computing from the speed of the spindle. *Rule:* Divide 1 by the circumference of the bobbin in inches. *Example:* Suppose a filling bobbin is 1½ inches in circumference at the barrel. $1 \div 1.5 = 0.67$=loss there. If it is 3 inches in circumference at the outside the loss there=$1 \div 3 = 0.33$. Average loss from computed twist 0.50, or half a turn per inch.

The best way to find the actual speed of spindles:—

Make some mark on the end of the cylinder so an assistant can turn it by hand slowly just once around. Mark the heads of several bobbins, or mark the whirls of the spindles, so as to be able to count the average number of turns of the spindle to one turn of the cylinder. Then multiply this number by the revolutions per minute the cylinder makes, ascertained carefully with a good speed-counter; or attach revolving-shaft of a speed-counter to tip of spindle with a rubber tube.

The result obtained by either of these methods is nearer the actual

speed of the spindle than the result obtained from computation in the usual way, because of the differences due to the size of the banding and the angle of the groove in the whirl.

To find the length of yarn in a bobbin:—

Multiply the circumference of the front roll in inches by the number of revolutions per minute, and this product by the number of minutes required to fill the bobbin; divide by 36 and deduct the contraction in twisting, and the result will be the number of yarns on the bobbin.

To determine the twist of a spinning frame:—

Multiply the teeth in driven gears for a dividend; divide this by the teeth in cylinder gear; then multiply this by the ratio between the cylinder and whorl and then divide by 3.1416 for a constant. This constant divided by the twist gear used will give the twist in one inch of yarn, thus:

Drivers.	cyl.	Ratio between cyl. & whorl.	
85 x 91	÷ 30	257.8 x 7.60	÷ 3.1416 = 6.23=constant.

This divided by twist gear will give the twist in one inch of yarn, or divided by twist required will give the twist gear.

To determine the size of a cord, when yarn of several different sizes have been used to make it:—

Reduce each yarn to grains, add the grains together and divide 1000 by this product and the result will be the size of cord. Thus:

12s, 16s & 18s twisted together.				
12s	reduced to	grains	equals	83.33
16s	"	"	"	62.50
18s	"	"	"	55.56
				201.39 divided into 1000 equals 4.92 equals the size of the cord.

One way to determine a constant for twist:—

Spin two rovings of the same hank, one white and one black, together; then count the turns of twist in one inch. This multiplied by teeth in the twist gear will give constant; this constant divided by twist required will give twist gear to use, or dividing by twist gear used will give twist in one inch of yarn.

Another way to find the draft on a spinning frame:—

Multiply the driving gears together, and this product by 7 if the middle and back rolls are 7-8 inches in diameter, for a divisor; multiply all driven gears together, and that product by 8, if the front rolls are one inch in diameter, for a dividend; and the quotient will be the draft. If you want a constant number, multiply the teeth of the change gears that you use on these frames by the draft thus obtained, and the result is the constant number, thus:

Back Stud	Roll	Front Roll	Draft	Draft of Frame	Constant.
(70 x 55	x 8) ÷	(20 x 30	x 7) =	7.333 x 30	= 220.

This divided by draft required will give gear to use.

To determine the product of a spindle in hanks:—

Divide the revolution of the front roll by 2.9 for 58 hours, and for any other number of hours in same proportion. For example, what will the divisor be for 60 hours ? 58 x 2.9 ÷ 60 = 2.8; therefore the speed of the front roll divided by 2.8 will give the product of a spindle in hanks for 60 hours; to reduce to pounds, divide by the size of yarn.

To determine the ratio between the cylinder and whorl:—

Divide the diameter of the cylinder plus the diameter of the band by the

diameter of whorl plus the diameter of band, thus,

Cylinder, 7 in.
Dia. of band 1-8 "

$$7\ 1\text{-}8 \text{ in.} = \frac{57}{8} \div \frac{15}{16} = 7.6$$

The whorl is 13-16 and band is 1-8 inches, added together equals 15-16 inches.

Therefore, a cylinder 7 inches in diameter, running with a whorl 13-16 inches in diameter will turn the spindle 7.6 times.

Avoirdupois Weight.

Grains.		Drachms.		Ounces.		Pounds.		Ton.		Grammes.		Kilog.
27.34	=	1							=	1.77184		
437.5	=	16	=	1					=	28.34954		
7,000.0	=	256	=	16	=	1			=	453.59265		
						2000	=	1			=	907.18

Long Measure.

Inches.		Feet.		Yards.		Rods.		Furlongs.		Mile.		Metres.
12	=	1									=	.3048
36	=	3	=	1							=	.9144
198	=	16.5	=	5.5	=	1					=	5.0291
7,920	=	660	=	220	=	40	=	1			=	201.1643
63,360	=	5,280	=	1,760	=	320	=	8	1	=		1,609.3145

DIMENSIONS OF CIRCLES.

Diameter.		Circumference.	Area.	Diameter.		Circumference.	Area.
1-64	.015625	.04909	.00019	3-4	.75	2.35619	.44179
1-32	.03125	.09817	.00077	25-32	.78125	2.45437	.47937
3-64	.046875	.14726	.00173	13-16	.8125	2.55254	.51849
1-16	.0625	.19635	.00307	27-32	.84375	2.65072	.55914
3-32	.09375	.29452	.00690	7-8	.875	2.74889	.60132
1-8	.125	.39270	.01227	29-32	.90625	2.84707	.64504
5-32	.15625	.49087	.01917	15-16	.9375	2.94524	.69029
3-16	.1875	.58905	.02761	31-32	.96875	3.04342	.73708
7-32	.21875	.68722	.03758	**1**		**3.14159**	**.78540**
1-4	.25	.78540	.04909	1-16	1.0625	3.33794	.88664
9-32	.28125	.88357	.06213	1-8	1.125	3.53429	.99402
5-16	.3125	.98175	.07670	3-16	1.1875	3.73064	1.1075
11-32	.34375	1.07992	.09281	1-4	1.25	3.92699	1.2272
3-8	.375	1.17810	.11045	5-16	1.3125	4.12334	1.3530
13-32	.40625	1.27627	.12962	3-8	1.375	4.31969	1.4849
7-16	.4375	1.37445	.15033	7-16	1.4375	4.51604	1.6230
15-32	.46875	1.47262	.17257	1-2	1.5	4.71239	1.7671
1-2	.5	1.57080	.19635	9-16	1.5625	4.90874	1.9175
17-32	.53125	1.66897	.22166	5-8	1.625	5.10509	2.0739
9-16	.5625	1.76715	.24850	11-16	1.6875	5.30144	2.2365
19-32	.59375	1.86532	.27688	3-4	1.75	5.49779	2.4053
5-8	.625	1.96350	.30680	13-16	1.8125	5.69414	2.5802
21-32	.65625	2.06167	.33824	7-8	1.875	5.89049	2.7612
11-16	.6875	2.15984	.37122	15-16	1.9375	6.08684	2.9483
23-32	.71875	2.25802	.40574	**2**		**6.28319**	**3.1416**

NUMBERING YARNS.

Yarn is weighed by avoirdupois weight.

Silk.

The silk-worm forms the cocoon of two parallel filaments of silk; three to six cocoons are usually reeled off together, making a thread of raw silk containing six to twelve filaments. One authority states that 500 yards of five twin filaments weigh about 2.5 grains. The number of drachms (27.34 grains) that 1000 yards of this raw silk weighs is the number.

Silk is sold in the United States by the number of yards in one ounce.

Sewing silk is numbered irregularly by letters:

Letter,	000	00	0	A	B	C	D	E	EE	F	FF	G
Yards in one oz.,	2000	1600	1300	1000	850	650	550	400	330	262	212	125

Letter A silk has 16,000 yards in a pound, and equals about a No. 60 cotton sewing thread in weight.

Silk that cannot be reeled is carded, spun and numbered like cotton yarn, and is called spun silk.

Linen and Jute.

Barlow's History of Weaving, London (1878), gives the following table:

2½ yards	=	1 thread or round of the linen reel.												
300	"	=	120	"	=	1	cut.							
600	"	=	240	"	=	2	"	=	1	heer.				
1,800	"	=	720	"	=	6	"	=	3	"	=	1	slip.	
3,600	"	=	1,440	"	=	12	"	=	6	"	=	2	"	= 1 hank.
7,200	"	=	2,880	"	=	24	"	=	12	"	=	4	"	= 2 " = 1 hasp.
14,400	"	=	5,760	"	=	48	"	=	24	"	=	8	"	= 4 " = 2 " = 1 spyndle.

The number of cuts in one pound is the number of linen yarn.

The number of yards of linen yarn that weigh 23.33 grains is the number of the yarn.

The numbers by which linen sewing threads are sold represent three threads of the number twisted together, that is, No. 35 standard thread has three strands of No. 35 yarn in it.

Table for numbering Linen Yarn by the weight in grains of 300 yards or 1 lea (or cut).

Grains.	Number of yarn.	Grains.	Number of yarn.	Grains.	Number of yarn.	Grains.	Number of yarn.	Grains.	Number of yarn.	Grains.	Number of yarn.
100	70.	260	26.92	420	16.67	580	12.07	800	8.75	1500	4.67
110	63.64	270	25.93	430	16.28	590	11.86	825	8.48	1600	4.37
120	58.33	280	25.	440	15.91	600	11.67	850	8.24	1700	4.12
130	53.85	290	24.14	450	15.56	610	11.48	875	8.	1800	3.89
140	50.	300	23.33	460	15.22	620	11.29	900	7.78	1900	3.68
150	46.67	310	22.58	470	14.89	630	11.11	925	7.57	2000	3.50
160	43.75	320	21.87	480	14.58	640	10.94	950	7.37	2250	3.11
170	41.18	330	21.21	490	14.29	650	10.77	975	7.18	2500	2.80
180	38.89	340	20.59	500	14.	660	10.61	1000	7.	2750	2.55
190	36.84	350	20.	510	13.73	670	10.45	1050	6.67	3000	2.33
200	35.	360	19.44	520	13.46	680	10.29	1100	6.36	3250	2.15
210	33.33	370	18.92	530	13.21	690	10.14	1150	6.09	3500	2.
220	31.82	380	18.42	540	12.96	700	10.	1200	5.83	4000	1.75
230	30.43	390	17.95	550	12.73	725	9.66	1250	5.60	5000	1.40
240	29.17	400	17.50	560	12.50	750	9.33	1300	5.38	6000	1.17
250	28.	410	17.07	570	12.28	775	9.03	1400	5.	7000	1.

Woollen.

1 yard=1 thread or round of the woollen reel.
80 " =1 knot.
300 " =3¾ " =1 cut.
1,600 " =20 " =5⅓ " =1 run.
2,000 " =25 " =6⅔ " =1¼ " =1 bier.

The number of runs in one pound is the number of woollen yarn.

The number of yards of woollen yarn that weigh 4.375 grains is the number of the yarn.

Table for numbering Woollen Yarn by the weight in grains of twenty yards, or one fourth of a knot.

Grains.	Runs.	Grains.	Runs.	Grains.	Runs.	Grains.	Runs.	Grains.	Runs.	Grains.	Runs.
1	87.50	18	4.86	35	2.50	52	1.68	69	1.27	86	1.02
2	43.75	19	4.61	36	2.43	53	1.65	70	1.25	87	1.01
3	29.17	20	4.37	37	2.36	54	1.62	71	1.23	88	.99
4	21.87	21	4.17	38	2.30	55	1.59	72	1.22	89	.98
5	17.50	22	3.98	39	2.24	56	1.56	73	1.20	90	.97
6	14.58	23	3.80	40	2.19	57	1.54	74	1.18	91	.96
7	12.50	24	3.65	41	2.13	58	1.51	75	1.17	92	.95
8	10.94	25	3.50	42	2.08	59	1.48	76	1.15	93	.94
9	9.72	26	3.37	43	2.03	60	1.46	77	1.14	94	.93
10	8.75	27	3.24	44	1.99	61	1.43	78	1.12	95	.92
11	7.95	28	3.12	45	1.94	62	1.41	79	1.11	96	.91
12	7.29	29	3.02	46	1.90	63	1.38	80	1.09	97	.90
13	6.73	30	2.92	47	1.86	64	1.37	81	1.08	98	.89
14	6.25	31	2.82	48	1.82	65	1.35	82	1.07	99	.88
15	5.83	32	2.73	49	1.79	66	1.33	83	1.05	100	.87
16	5.47	33	2.65	50	1.75	67	1.31	84	1.04		
17	5.15	34	2.57	51	1.72	68	1.29	85	1.03		

The number of yarn of different sizes represents the proportionate size of No. 1 yarn, and to determine the size or number of a thread composed of strands of different numbers twisted together, it is only necessary to add together the proportionate sizes of the separate strands. A single example will illustrate: 3 run, 4 run, 5 run and 6 run twisted together will make yarn the size of $\frac{1}{3}\times\frac{1}{4}\times\frac{1}{5}\times\frac{1}{6}$ of 1 run, or $\frac{20}{60}\times\frac{15}{60}\times\frac{12}{60}\times\frac{10}{60}=\frac{57}{60}$ of 1 run; not quite so large as one run, but exactly 60÷57=1.05 run.

Worsted.

1 yard, =1 thread or round of the worsted reel.
80 " =80 " =1 lea or knot.
560 " =560 " =7 " " =1 hank.

The number of hanks in one pound is the number of worsted yarn.

The number of a worsted yarn of a given length which equals in weight a cotton yarn of the same length, is equal to the cotton number multiplied by 1.5. No. 60 cotton No. 90 worsted.

The number of yards of worsted yarn that weigh 12.5 grains is the number of the yarn.

Table for numbering Worsted Yarn by the weight in grains of twenty yards, or one fourth of a knot.

Grains.	No. of Yarn.	Grains.	No. of Yarn.	Grains.	No. of Yarn.	Grains.	No. of Yarn.	Grains.	No. of Yarn.	Grains.	No. of Yarn.
1	250.	19	13.16	37	6.76	55	4.55	73	3.42	91	2.75
2	125.	20	12.50	38	6.58	56	4.46	74	3.38	92	2.72
3	83.33	21	11.90	39	6.41	57	4.39	75	3.33	93	2.69
4	62.50	22	11.36	40	6.25	58	4.31	76	3.29	94	2.66
5	50.	23	10.87	41	6.10	59	4.24	77	3.25	95	2.63
6	41.67	24	10.42	42	5.95	60	4.17	78	3.21	96	2.60
7	35.71	25	10.	43	5.81	61	4.10	79	3.17	97	2.58
8	31.25	26	9.62	44	5.68	62	4.03	80	3.12	98	2.55
9	27.78	27	9.26	45	5.56	63	3.97	81	3.09	99	2.52
10	25.	28	8.93	46	5.43	64	3.91	82	3.05	100	2.50
11	22.73	29	8.62	47	5.32	65	3.85	83	3.01	105	2.38
12	20.83	30	8.33	48	5.21	66	3.79	84	2.98	110	2.27
13	19.23	31	8.06	49	5.10	67	3.73	85	2.94	115	2.17
14	17.86	32	7.81	50	5.	68	3.68	86	2.91	120	2.08
15	16.67	33	7.58	51	4.90	69	3.62	87	2.87	125	2.
16	15.62	34	7.35	52	4.81	70	3.57	88	2.84	150	1.67
17	14.71	35	7.14	53	4.72	71	3.52	89	2.81	175	1.43
18	13.89	36	6.94	54	4.63	72	3.47	90	2.78	200	1.25

Cotton.

1½ yards =1 thread or round of the cotton reel.
120 " =80 " =1 skein, ley or lea.
840 " =560 " =7 skeins=1 hank.

The number of hanks in one pound, is the number of cotton yarn.

The number of yards of cotton yarn that weigh 8.33 grains, is the number of the yarn.

The numbers by which cotton sewing threads are sold represent three threads of the number twisted together, that is, No. 60 standard thread has three strands of No. 60 yarn in it. In a six-cord thread each of the three strands is made up of two threads twisted together. Six threads of No. 120 make six-cord No. 60.

The French system of numbering is based on the Metric system. The metre=39.37 inches, and is the standard of length. The kilogram (2.2047 pounds) is the standard weight in numbering yarn, and the number of thousand metres in a kilogram is the number of the yarn. No. 28 yarn would be No. 47.42 in France.

By the various standards, No. 1 yarn has the following numbers of yards in one pound:

Cotton and spun silk	840
Linen	300
Woollen	1,600
Worsted	560

The following tables have been carefully computed, and are, we believe, correct.

The tables for numbering cotton yarn by the weight of one skein are also printed separately for the use of spinners, and we will mail a copy to any overseer who will send to us for it, and give his address plainly written.

Comparative Numbers of Yarn of different materials of the same weight per yard.

Cot.	Woollen.	Worst.	Linen.	Silk.	Cot.	Woollen.	Worst.	Linen.	Silk.
Hanks of 840 yards.	Runs of 1,600 yards.	Hanks of 560 yards.	Cuts of 300 yards.	Yards in one ounce.	Hanks of 840 yards.	Runs of 1,600 yards.	Hanks of 560 yards.	Cuts of 300 yards.	Yards in one ounce.
1	.525	**1.5**	**2.8**	**52.5**	71	37.275	106.5	198.8	3727.5
2	1.05	3.	5.6	105.	72	37.8	108.	201.6	3780.
3	1.575	4.5	8.4	157.5	73	38.325	109.5	204.4	3832.5
4	2.1	6.	11.2	210.	74	38.85	111.	207.2	3885.
5	2.625	7.5	14.	262.5	75	39.375	112.5	210.	3937.5
6	3.15	9.	16.8	315.	76	39.9	114.	212.8	3990.
7	3.675	10.5	19.6	367.5	77	40.425	115.5	215.6	4042.5
8	4.2	12.	22.4	420.	78	40.95	117.	218.4	4095.
9	4.725	13.5	25.2	472.5	79	41.475	118.5	221.2	4147.5
10	5.25	15.	28.	525.	**80**	42.	120.	224.	4200.
11	5.775	16.5	30.8	577.5	81	42.525	121.5	226.8	4252.5
12	6.3	18.	33.6	630.	82	43.05	123.	229.6	4305.
13	6.825	19.5	36.4	682.5	83	43.575	124.5	232.4	4357.5
14	7.35	21.	39.2	735.	84	44.1	126.	235.2	4410.
15	7.875	22.5	42.	787.5	85	44.625	127.5	238.	4462.5
16	8.4	24.	44.8	840.	86	45.15	129.	240.8	4515.
17	8.925	25.5	47.6	892.5	87	45.675	130.5	243.6	4567.5
18	9.45	27.	50.4	945.	88	46.2	132.	246.4	4620.
19	9.975	28.5	53.2	997.5	89	46.725	133.5	249.2	4672.5
20	10.5	30.	56.	1050.	**90**	47.25	135.	252.	4725.
21	11.025	31.5	58.8	1102.5	91	47.775	136.5	254.8	4777.5
22	11.55	33.	61.6	1155.	92	48.3	138.	257.6	4830.
23	12.075	34.5	64.4	1207.5	93	48.825	139.5	260.4	4882.5
24	12.6	36.	67.2	1260.	94	49.35	141.	263.2	4935.
25	13.125	37.5	70.	1312.5	95	49.875	142.5	266.	4987.5
26	13.65	39.	72.8	1365.	96	50.4	144.	268.8	5040.
27	14.175	40.5	75.6	1417.5	97	50.925	145.5	271.6	5092.5
28	14.7	42.	78.4	1470.	98	51.45	147.	274.4	5145.
29	15.225	43.5	81.2	1522.5	99	51.975	148.5	277.2	5197.5
30	15.75	45.	84.	1575.	**100**	52.5	150.	280.	5250.
31	16.275	46.5	86.8	1627.5	101	53.025	151.5	282.8	5302.5
32	16.8	48.	89.6	1680.	102	53.55	153.	285.6	5355.
33	17.325	49.5	92.4	1732.5	103	54.075	154.5	288.4	5407.5
34	17.85	51.	95.2	1785.	104	54.6	156.	291.2	5460.
35	18.375	52.5	98.	1837.5	105	55.125	157.5	294.	5512.5
36	18.9	54.	100.8	1890.	106	55.65	159.	296.8	5565.
37	19.425	55.5	103.6	1942.5	107	56.175	160.5	299.6	5617.5
38	19.95	57.	106.4	1995.	108	56.7	162.	302.4	5670.
39	20.475	58.5	109.2	2047.5	109	57.225	163.5	305.2	5722.5
40	21.	60.	112.	2100.	**110**	57.75	165.	308.	5775.
41	21.525	61.5	114.8	2152.5	111	58.275	166.5	310.8	5827.5
42	22.05	63.	117.6	2205.	112	58.8	168.	313.6	5880.
43	22.575	64.5	120.4	2257.5	113	59.325	169.5	316.4	5932.5
44	23.1	66.	123.2	2310.	114	59.85	171.	319.2	5985.
45	23.625	67.5	126.	2362.5	115	60.375	173.5	322.	6037.5
46	24.15	69.	128.8	2415.	116	60.9	174.	324.8	6090.
47	24.675	70.5	131.6	2467.5	117	61.425	175.5	327.6	6142.5
48	25.2	72.	134.4	2520.	118	61.95	177.	330.4	6195.
49	25.725	73.5	137.2	2572.5	119	62.475	178.5	333.2	6247.5
50	26.25	75.	140.	2625.	**120**	63.	180.	336.	6300.
51	26.775	76.5	142.8	2677.5	121	63.525	181.5	338.8	6352.5
52	27.3	78.	145.6	2730.	122	64.05	183.	341.6	6405.
53	27.825	79.5	148.4	2782.5	123	64.575	184.5	344.4	6457.5
54	28.35	81.	151.2	2835.	124	65.1	186.	347.2	6510.
55	28.875	82.5	154.	2887.5	125	65.625	187.5	350.	6562.5
56	29.4	84.	156.8	2940.	126	66.15	189.	352.8	6615.
57	29.925	85.5	159.6	2992.5	127	66.675	190.5	355.6	6667.5
58	30.45	87.	162.4	3045.	128	67.2	192.	358.4	6720.
59	30.975	88.5	165.2	3097.5	129	67.725	193.5	361.2	6772.5
60	31.5	90.	168.	3150.	**130**	68.25	195.	364.	6825.
61	32.025	91.5	170.8	3202.5	131	68.775	196.5	366.8	6877.5
62	32.55	93.	173.6	3255.	132	69.3	198.	369.6	6930.
63	33.075	94.5	176.4	3307.5	133	69.825	199.5	372.4	6982.5
64	33.6	96.	179.2	3360.	134	70.35	201.	375.2	7035.
65	34.125	97.5	182.	3412.5	135	70.875	202.5	378.	7087.5
66	34.65	99.	184.8	3465.	136	71.4	204.	380.8	7140.
67	35.175	100.5	187.6	3517.5	137	71.925	205.5	383.6	7192.5
68	35.7	102.	190.4	3570.	138	72.45	207.	386.4	7245.
69	36.225	103.5	193.2	3622.5	139	72.975	208.5	389.2	7297.5
70	36.75	105.	196.	3675.	**140**	73.5	210.	392.	7350.

Table for numbering Cotton Yarn by the weight in grains of 120 yards or 1 skein.

120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains	Number of Yarn	120yds. weigh grains.	Number of Yarn.
1.	1000.	**14.**	71.43	**21.**	47.62	**28.**	35.71	**35.**	28.57
2.	500.	.1	70.92	.1	47.39	.1	35.59	.1	28.49
3.	333.3	.2	70.42	.2	47.17	.2	35.46	.2	28.41
4.	250.0	.3	69.93	.3	46.95	.3	35.34	.3	28.33
5.	200.0	.4	69.44	.4	46.73	.4	35.21	.4	28.25
5.5	181.8	.5	68.97	.5	46.51	.5	35.09	.5	28.17
6.	166.7	.6	68.49	.6	46.30	.6	34.97	.6	28.09
6.5	153.8	.7	68.03	.7	46.08	.7	34.84	.7	28.01
7.	142.9	.8	67.57	.8	45.87	.8	34.72	.8	27.93
7.5	133.3	.9	67.11	.9	45.66	.9	34.60	.9	27.86
8.	125.0	**15.**	66.67	**22.**	45.45	**29.**	34.48	**36.**	27.78
.1	123.5	.1	66.23	.1	45.25	.1	34.36	.1	27.70
.2	122.0	.2	65.79	.2	45.05	.2	34.25	.2	27.62
.3	120.5	.3	65.36	.3	44.84	.3	34.13	.3	27.55
.4	119.0	.4	64.94	.4	44.64	.4	34.01	.4	27.47
.5	117.6	.5	64.52	.5	44.44	.5	33.90	.5	27.40
.6	116.3	.6	64.10	.6	44.25	.6	33.78	.6	27.32
.7	114.9	.7	63.69	.7	44.05	.7	33.67	.7	27.25
.8	113.6	.8	63.29	.8	43.86	.8	33.56	.8	27.17
.9	112.4	.9	62.89	.9	43.67	.9	33.44	.9	27.10
9.	111.1	**16.**	62.50	**23.**	43.48	**30.**	33.33	**37.**	27.03
.1	109.9	.1	62.11	.1	43.29	.1	33.22	.1	26.95
.2	108.7	.2	61.73	.2	43.10	.2	33.11	.2	26.88
.3	107.5	.3	61.35	.3	42.92	.3	33.00	.3	26.81
.4	106.4	.4	60.98	.4	42.74	.4	32.89	.4	26.74
.5	105.3	.5	60.61	.5	42.55	.5	32.79	.5	26.67
.6	104.2	.6	60.24	.6	42.37	.6	32.68	.6	26.60
.7	103.1	.7	59.88	.7	42.19	.7	32.57	.7	26.53
.8	102.0	.8	59.52	.8	42.02	.8	32.47	.8	26.46
.9	101.0	.9	59.17	.9	41.84	.9	32.36	.9	26.39
10.	100.0	**17.**	58.82	**24.**	41.67	**31.**	32.26	**38.**	26.32
.1	99.01	.1	58.48	.1	41.49	.1	32.16	.1	26.25
.2	98.04	.2	58.14	.2	41.32	.2	32.05	.2	26.18
.3	97.09	.3	57.80	.3	41.15	.3	31.95	.3	26.11
.4	96.15	.4	57.47	.4	40.98	.4	31.85	.4	26.04
.5	95.24	.5	57.14	.5	40.82	.5	31.75	.5	25.97
.6	94.34	.6	56.82	.6	40.65	.6	31.65	.6	25.91
.7	93.46	.7	56.50	.7	40.49	.7	31.55	.7	25.84
.8	92.59	.8	56.18	.8	40.32	.8	31.45	.8	25.77
.9	91.74	.9	55.87	.9	40.16	.9	31.35	.9	25.71
11.	90.91	**18.**	55.56	**25.**	40.00	**32.**	31.25	**39.**	25.64
.1	90.09	.1	55.25	.1	39.84	.1	31.15	.1	25.58
.2	89.29	.2	54.95	.2	39.68	.2	31.06	.2	25.51
.3	88.50	.3	54.64	.3	39.53	.3	30.96	.3	25.45
.4	87.72	.4	54.35	.4	39.37	.4	30.86	.4	25.38
.5	86.96	.5	54.05	.5	39.22	.5	30.77	.5	25.32
.6	86.21	.6	53.76	.6	39.06	.6	30.67	.6	25.25
.7	85.47	.7	53.48	.7	38.91	.7	30.58	.7	25.19
.8	84.75	.8	53.19	.8	38.76	.8	30.49	.8	25.13
.9	84.03	.9	52.91	.9	38.61	.9	30.40	.9	25.06
12.	83.33	**19.**	52.63	**26.**	38.46	**33.**	30.30	**40.**	25.00
.1	82.64	.1	52.36	.1	38.31	.1	30.21	.1	24.94
.2	81.97	.2	52.08	.2	38.17	.2	30.12	.2	24.88
.3	81.30	.3	51.81	.3	38.02	.3	30.03	.3	24.81
.4	80.65	.4	51.55	.4	37.88	.4	29.94	.4	24.75
.5	80.00	.5	51.28	.5	37.74	.5	29.85	.5	24.69
.6	79.37	.6	51.02	.6	37.59	.6	29.76	.6	24.63
.7	78.74	.7	50.76	.7	37.45	.7	29.67	.7	24.57
.8	78.12	.8	50.51	.8	37.31	.8	29.59	.8	24.51
.9	77.52	.9	50.25	.9	37.17	.9	29.50	.9	24.45
13.	76.92	**20.**	50.00	**27.**	37.04	**34.**	29.41	**41.**	24.39
.1	76.34	.1	49.75	.1	36.90	.1	29.33	.1	24.33
.2	75.76	.2	49.50	.2	36.77	.2	29.24	.2	24.27
.3	75.19	.3	49.26	.3	36.63	.3	29.15	.3	24.21
.4	74.63	.4	49.02	.4	36.50	.4	29.07	.4	24.15
.5	74.07	.5	48.78	.5	36.36	.5	28.99	.5	24.10
.6	73.53	.6	48.54	.6	36.23	.6	28.90	.6	24.04
.7	72.99	.7	48.31	.7	36.10	.7	28.82	.7	23.98
.8	72.46	.8	48.08	.8	35.97	.8	28.74	.8	23.92
.9	71.94	.9	47.85	.9	35.84	.9	28.65	.9	23.87

Table for numbering Cotton Yarn by the weight in grains of 120 yards or 1 skein,

120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.
42.	23.81	**49.**	20.41	**56.**	17.86	**63.**	15.87	**70.**	14.29
.1	23.75	.1	20.37	.1	17.83	.1	15.85	.1	14.27
.2	23.70	.2	20.33	.2	17.79	.2	15.83	.2	14.25
.3	23.64	.3	20.28	.3	17.76	.3	15.80	.3	14.22
.4	23.58	.4	20.24	.4	17.73	.4	15.77	.4	14.20
.5	23.53	.5	20.20	.5	17.70	.5	15.75	.5	14.18
.6	23.47	.6	20.16	.6	17.67	.6	15.72	.6	14.16
.7	23.42	.7	20.12	.7	17.64	.7	15.70	.7	14.14
.8	23.36	.8	20.08	.8	17.61	.8	15.67	.8	14.12
.9	23.31	.9	20.04	.9	17.57	.9	15.65	.9	14.10
43.	23.26	**50.**	20.00	**57.**	17.54	**64.**	15.62	**71.**	14.08
.1	23.20	.1	19.96	.1	17.51	.1	15.60	.1	14.06
.2	23.15	.2	19.92	.2	17.48	.2	15.58	.2	14.04
.3	23.09	.3	19.88	.3	17.45	.3	15.55	.3	14.03
.4	23.04	.4	19.84	.4	17.42	.4	15.53	.4	14.01
.5	22.99	.5	19.80	.5	17.39	.5	15.50	.5	13.99
.6	22.94	.6	19.76	.6	17.36	.6	15.48	.6	13.97
.7	22.88	.7	19.72	.7	17.33	.7	15.46	.7	13.95
.8	22.83	.8	19.69	.8	17.30	.8	15.43	.8	13.93
.9	22.78	.9	19.65	.9	17.27	.9	15.41	.9	13.91
44.	22.73	**51.**	19.61	**58.**	17.24	**65.**	15.38	**72.**	13.89
.1	22.68	.1	19.57	.1	17.21	.1	15.36	.1	13.87
.2	22.62	.2	19.53	.2	17.18	.2	15.34	.2	13.85
.3	22.57	.3	19.49	.3	17.15	.3	15.31	.3	13.83
.4	22.52	.4	19.46	.4	17.12	.4	15.29	.4	13.81
.5	22.47	.5	19.42	.5	17.09	.5	15.27	.5	13.79
.6	22.42	.6	19.38	.6	17.06	.6	15.24	.6	13.77
.7	22.37	.7	19.34	.7	17.04	.7	15.22	.7	13.76
.8	22.32	.8	19.31	.8	17.01	.8	15.20	.8	13.74
.9	22.27	.9	19.27	.9	16.98	.9	15.17	.9	13.72
45.	22.22	**52.**	19.23	**59.**	16.95	**66.**	15.15	**73.**	13.70
.1	22.17	.1	19.19	.1	16.92	.1	15.13	.1	13.68
.2	22.12	.2	19.16	.2	16.89	.2	15.11	.2	13.66
.3	22.08	.3	19.12	.3	16.86	.3	15.08	.3	13.64
.4	22.03	.4	19.08	.4	16.84	.4	15.06	.4	13.62
.5	21.98	.5	19.05	.5	16.81	.5	15.04	.5	13.61
.6	21.93	.6	19.01	.6	16.78	.6	15.02	.6	13.59
.7	21.88	.7	18.98	.7	16.75	.7	14.99	.7	13.57
.8	21.83	.8	18.94	.8	16.72	.8	14.97	.8	13.55
.9	21.79	.9	18.90	.9	16.69	.9	14.95	.9	13.53
46.	21.74	**53.**	18.87	**60.**	16.67	**67.**	14.93	**74.**	13.51
.1	21.69	.1	18.83	.1	16.64	.1	14.90	.1	13.50
.2	21.65	.2	18.80	.2	16.61	.2	14.88	.2	13.48
.3	21.60	.3	18.76	.3	16.58	.3	14.86	.3	13.46
.4	21.55	.4	18.73	.4	16.56	.4	14.84	.4	13.44
.5	21.51	.5	18.69	.5	16.53	.5	14.81	.5	13.42
.6	21.46	.6	18.66	.6	16.50	.6	14.79	.6	13.40
.7	21.41	.7	18.62	.7	16.47	.7	14.77	.7	13.39
.8	21.37	.8	18.59	.8	16.45	.8	14.75	.8	13.37
.9	21.32	.9	18.55	.9	16.42	.9	14.73	.9	13.35
47.	21.28	**54.**	18.52	**61.**	16.39	**68.**	14.71	**75.**	13.33
.1	21.23	.1	18.48	.1	16.37	.1	14.68	.1	13.32
.2	21.19	.2	18.45	.2	16.34	.2	14.66	.2	13.30
.3	21.14	.3	18.42	.3	16.31	.3	14.64	.3	13.28
.4	21.10	.4	18.38	.4	16.29	.4	14.62	.4	13.26
.5	21.05	.5	18.35	.5	16.26	.5	14.60	.5	13.25
.6	21.01	.6	18.32	.6	16.23	.6	14.58	.6	13.23
.7	20.96	.7	18.28	.7	16.21	.7	14.56	.7	13.21
.8	20.92	.8	18.25	.8	16.19	.8	14.53	.8	13.19
.9	20.88	.9	18.21	.9	16.16	.9	14.51	.9	13.18
48.	20.83	**55.**	18.18	**62.**	16.13	**69.**	14.49	**76.**	13.16
.1	20.79	.1	18.15	.1	16.10	.1	14.47	.1	13.14
.2	20.75	.2	18.12	.2	16.08	.2	14.45	.2	13.12
.3	20.70	.3	18.08	.3	16.05	.3	14.43	.3	13.11
.4	20.66	.4	18.05	.4	16.03	.4	14.41	.4	13.09
.5	20.62	.5	18.02	.5	16.00	.5	14.39	.5	13.07
.6	20.57	.6	17.99	.6	15.97	.6	14.37	.6	13.05
.7	20.53	.7	17.95	.7	15.95	.7	14.35	.7	13.04
.8	20.49	.8	17.92	.8	15.92	.8	14.33	.8	13.02
.9	20.45	.9	17.89	.9	15.90	.9	14.31	.9	13.00

Table for numbering Cotton Yarn by the weight in grains of 120 yards or 1 skein.

120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.
77.	12.99	**84.**	11.90	**91.**	10.99	**98.**	10.20	**105.**	9.52
.1	12.97	.1	11.89	.1	10.98	.1	10.19	.1	9.51
.2	12.95	.2	11.88	.2	10.96	.2	10.18	.2	9.51
.3	12.94	.3	11.86	.3	10.95	.3	10.17	.3	9.50
.4	12.92	.4	11.85	.4	10.94	.4	10.16	.4	9.49
.5	12.90	.5	11.83	.5	10.93	.5	10.15	.5	9.48
.6	12.89	.6	11.82	.6	10.92	.6	10.14	.6	9.47
.7	12.87	.7	11.81	.7	10.91	.7	10.13	.7	9.46
.8	12.85	.8	11.79	.8	10.89	.8	10.12	.8	9.45
.9	12.84	.9	11.78	.9	10.88	.9	10.11	.9	9.44
78.	12.82	**85.**	11.76	**92.**	10.87	**99.**	10.10	**106.**	9.43
.1	12.80	.1	11.75	.1	10.86	.1	10.09	.1	9.43
.2	12.79	.2	11.74	.2	10.85	.2	10.08	.2	9.42
.3	12.77	.3	11.72	.3	10.83	.3	10.07	.3	9.41
.4	12.76	.4	11.71	.4	10.82	.4	10.06	.4	9.40
.5	12.74	.5	11.70	.5	10.81	.5	10.05	.5	9.39
.6	12.72	.6	11.68	.6	10.80	.6	10.04	.6	9.38
.7	12.71	.7	11.67	.7	10.79	.7	10.03	.7	9.37
.8	12.69	.8	11.66	.8	10.78	.8	10.02	.8	9.36
.9	12.67	.9	11.64	.9	10.76	.9	10.01	.9	9.35
79.	12.66	**86.**	11.63	**93.**	10.75	**100.**	10.00	**107.**	9.35
.1	12.64	.1	11.61	.1	10.74	.1	9.99	.1	9.34
.2	12.63	.2	11.60	.2	10.73	.2	9.98	.2	9.33
.3	12.61	.3	11.59	.3	10.72	.3	9.97	.3	9.32
.4	12.59	.4	11.57	.4	10.71	.4	9.96	.4	9.31
.5	12.58	.5	11.56	.5	10.70	.5	9.95	.5	9.30
.6	12.56	.6	11.55	.6	10.68	.6	9.94	.6	9.29
.7	12.55	.7	11.53	.7	10.67	.7	9.93	.7	9.29
.8	12.53	.8	11.52	.8	10.66	.8	9.92	.8	9.28
.9	12.52	.9	11.51	.9	10.65	.9	9.91	.9	9.27
80.	12.50	**87.**	11.49	**94.**	10.64	**101.**	9.90	**108.**	9.26
.1	12.48	.1	11.48	.1	10.63	.1	9.89	.1	9.25
.2	12.47	.2	11.47	.2	10.62	.2	9.88	.2	9.24
.3	12.45	.3	11.45	.3	10.60	.3	9.87	.3	9.23
.4	12.44	.4	11.44	.4	10.59	.4	9.86	.4	9.23
.5	12.42	.5	11.43	.5	10.58	.5	9.85	.5	9.22
.6	12.41	.6	11.42	.6	10.57	.6	9.84	.6	9.21
.7	12.39	.7	11.40	.7	10.56	.7	9.83	.7	9.20
.8	12.38	.8	11.39	.8	10.55	.8	9.82	.8	9.19
.9	12.36	.9	11.38	.9	10.54	.9	9.81	.9	9.18
81.	12.35	**88.**	11.36	**95.**	10.53	**102.**	9.80	**109.**	9.17
.1	12.33	.1	11.35	.1	10.52	.1	9.79	.2	9.16
.2	12.32	.2	11.34	.2	10.50	.2	9.78	.4	9.14
.3	12.30	.3	11.33	.3	10.49	.3	9.78	.6	9.12
.4	12.29	.4	11.31	.4	10.48	.4	9.77	.8	9.11
.5	12.27	.5	11.30	.5	10.47	.5	9.76	**110.**	9.09
.6	12.25	.6	11.29	.6	10.46	.6	9.75	.2	9.07
.7	12.24	.7	11.27	.7	10.45	.7	9.74	.4	9.06
.8	12.22	.8	11.26	.8	10.44	.8	9.73	.6	9.04
.9	12.21	.9	11.25	.9	10.43	.9	9.72	.8	9.03
82.	12.20	**89.**	11.24	**96.**	10.42	**103.**	9.71	**111.**	9.01
.1	12.18	.1	11.22	.1	10.41	.1	9.70	.2	8.99
.2	12.17	.2	11.21	.2	10.40	.2	9.69	.4	8.98
.3	12.15	.3	11.20	.3	10.38	.3	9.68	.6	8.96
.4	12.14	.4	11.19	.4	10.37	.4	9.67	.8	8.94
.5	12.12	.5	11.17	.5	10.36	.5	9.66	**112.**	8.93
.6	12.11	.6	11.16	.6	10.35	.6	9.65	.2	8.91
.7	12.09	.7	11.15	.7	10.34	.7	9.64	.4	8.90
.8	12.08	.8	11.14	.8	10.33	.8	9.63	.6	8.88
.9	12.06	.9	11.12	.9	10.32	.9	9.62	.8	8.87
83.	12.05	**90.**	11.11	**97.**	10.31	**104.**	9.62	**113.**	8.85
.1	12.03	.1	11.10	.1	10.30	.1	9.61	.2	8.83
.2	12.02	.2	11.09	.2	10.29	.2	9.60	.4	8.82
.3	12.00	.3	11.07	.3	10.28	.3	9.59	.6	8.80
.4	11.99	.4	11.06	.4	10.27	.4	9.58	.8	8.79
.5	11.98	.5	11.05	.5	10.26	.5	9.57	**114.**	8.77
.6	11.96	.6	11.04	.6	10.25	.6	9.56	.2	8.76
.7	11.95	.7	11.03	.7	10.24	.7	9.55	.4	8.74
.8	11.93	.8	11.01	.8	10.22	.8	9.54	.6	8.73
.9	11.92	.9	11.00	.9	10.21	.9	9.53	.8	8.71

Table for numbering Cotton Yarn by the weight in grains of 120 yards or 1 skein.

120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn	120yds. weigh grains.	Number of Yarn.
115.	8.70	**140.**	7.14	**180.**	5.56	**250.**	4.00	**400.**	2.50
.2	8.68	.5	7.12	181.	5.52	252.	3.97	405.	2.47
.4	8.67	141.	7.09	182.	5.49	254.	3.94	410.	2.44
.6	8.65	.5	7.07	183.	5.46	256.	3.91	415.	2.41
.8	8.64	142.	7.04	184.	5.43	258.	3.88	420.	2.38
116.	8.62	.5	7.02	185.	5.41	260.	3.85	425.	2.35
.2	8.61	143.	6.99	186.	5.38	262.	3.82	430.	2.33
.4	8.59	.5	6.97	187.	5.35	264.	3.79	435.	2.30
.6	8.58	144.	6.94	188.	5.32	266.	3.76	440.	2.27
.8	8.56	.5	6.92	189.	5.29	268.	3.73	445.	2.25
117.	8.55	**145.**	6.90	**190.**	5.26	**270.**	3.70	**450.**	2.22
.2	8.53	.5	6.87	191.	5.24	272.	3.68	455.	2.20
.4	8.52	146.	6.85	192.	5.21	274.	3.65	460.	2.17
.6	8.50	.5	6.83	193.	5.18	276.	3.62	465.	2.15
.8	8.49	147.	6.80	194.	5.15	278.	3.60	470.	2.13
118.	8.47	.5	6.78	195.	5.13	280.	3.57	475.	2.11
.2	8.46	148.	6.76	196.	5.10	282.	3.55	480.	2.08
.4	8.45	.5	6.73	197.	5.08	284.	3.52	485.	2.06
.6	8.43	149.	6.71	198.	5.05	286.	3.50	490.	2.04
.8	8.42	.5	6.69	199.	5.03	288.	3.47	495.	2.02
119.	8.40	**150.**	6.67	**200.**	5.00	**290.**	3.45	**500.**	2.00
.2	8.39	.5	6.64	201.	4.98	292.	3.42	505.	1.98
.4	8.38	151.	6.62	202.	4.95	294.	3.40	510.	1.96
.6	8.36	.5	6.60	203.	4.93	296.	3.38	515.	1.94
.8	8.35	152.	6.58	204.	4.90	298.	3.36	520.	1.92
120.	8.33	.5	6.56	205.	4.88	300.	3.33	525.	1.90
.2	8.32	153.	6.54	206.	4.85	302.	3.31	530.	1.89
.4	8.31	.5	6.51	207.	4.83	304.	3.29	535.	1.87
.6	8.29	154.	6.49	208.	4.81	306.	3.27	540.	1.85
.8	8.28	.5	6.47	209.	4.78	308.	3.25	545.	1.83
121.	8.26	**155.**	6.45	**210.**	4.76	**310.**	3.23	**550.**	1.82
.4	8.24	.5	6.43	211.	4.74	312.	3.21	555.	1.80
.6	8.22	156.	6.41	212.	4.72	314.	3.18	560.	1.79
.8	8.21	.5	6.39	213.	4.69	316.	3.17	565.	1.77
122.	8.20	157.	6.37	214.	4.67	318.	3.14	570.	1.75
.5	8.16	.5	6.35	215.	4.65	320.	3.12	575.	1.74
123.	8.13	158.	6.33	216.	4.63	322.	3.11	580.	1.72
.5	8.10	.5	6.31	217.	4.61	324.	3.09	585.	1.71
124.	8.06	159.	6.29	218.	4.59	326.	3.07	590.	1.69
.5	8.03	.5	6.27	219.	4.57	328.	3.05	595.	1.68
125.	8.00	**160.**	6.25	**220.**	4.55	**330.**	3.03	**600.**	1.67
.5	7.97	.5	6.23	221.	4.52	332.	3.01	610.	1.64
126.	7.94	161.	6.21	222.	4.50	334.	2.99	620.	1.61
.5	7.91	.5	6.19	223.	4.48	336.	2.98	630.	1.59
127.	7.87	162.	6.17	224.	4.46	338.	2.96	640.	1.56
.5	7.84	.5	6.15	225.	4.44	340.	2.94	650.	1.54
128.	7.81	163.	6.13	226.	4.42	342.	2.92	660.	1.52
.5	7.78	.5	6.12	227.	4.41	344.	2.91	670.	1.49
129.	7.75	164.	6.10	228.	4.39	346.	2.89	680.	1.47
.5	7.72	.5	6.08	229.	4.37	348.	2.87	690.	1.45
130.	7.69	**165.**	6.06	**230.**	4.35	**350.**	2.86	**700.**	1.43
.5	7.66	.5	6.04	231.	4.33	352.	2.84	710.	1.41
131.	7.63	166.	6.02	232.	4.31	354.	2.82	720.	1.39
.5	7.60	.5	6.01	233.	4.29	356.	2.81	730.	1.37
132.	7.58	167.	5.99	234.	4.27	358.	2.79	740.	1.35
.5	7.55	.5	5.97	235.	4.26	360.	2.78	750.	1.33
133.	7.52	168.	5.95	236.	4.24	362.	2.76	760.	1.32
.5	7.49	.5	5.93	237.	4.22	364.	2.75	770.	1.30
134.	7.46	169.	5.92	238.	4.20	366.	2.73	780.	1.28
.5	7.43	.5	5.90	239.	4.18	368.	2.72	790.	1.27
135.	7.41	**170.**	5.88	**240.**	4.17	**370.**	2.70	**800.**	1.25
.5	7.38	171.	5.85	241.	4.15	372.	2.69	820.	1.22
136.	7.35	172.	5.81	242.	4.13	374.	2.67	840.	1.19
.5	7.33	173.	5.78	243.	4.12	376.	2.66	860.	1.16
137.	7.30	174.	5.75	244.	4.10	378.	2.65	880.	1.14
.5	7.27	175.	5.71	245.	4.08	380.	2.63	900.	1.11
138.	7.25	176.	5.68	246.	4.07	382.	2.62	925.	1.08
.5	7.22	177.	5.65	247.	4.05	385.	2.60	950.	1.05
139.	7.19	178.	5.62	248.	4.03	390.	2.56	975.	1.03
.5	7.17	179.	5.59	249.	4.02	395.	2.53	1000.	1.00

TWIST TABLE,

Showing the square root of the numbers or counts from 1 to 140 hanks in the pound, with the twist per inch for different kinds of yarn.

Counts or Numbers.	Square Root.	Ordinary Warp Twist.	Whitman's Warp Twist.	Extra Mule Warp Twist.	Mule Warp Twist.	Mule Filling Twist.
1	**1.0000**	**4.75**	**4.50**	**4.00**	**3.75**	**3.25**
2	1.4142	6.72	6.36	5.66	5.30	4.60
3	1.7321	8.23	7.79	6.93	6.50	5.63
4	2.0000	9.50	9.00	8.00	7.50	6.50
5	2.2361	10.62	10.06	8.94	8.39	7.27
6	2.4495	11.64	11.02	9.80	9.19	7.96
7	2.6458	12.57	11.91	10.58	9.92	8.60
8	2.8284	13.44	12.73	11.31	10.61	9.19
9	3.0000	14.25	13.50	12.00	11.25	9.75
10	3.1623	15.02	14.23	12.65	11.86	10.28
11	3.3166	15.75	14.92	13.27	12.44	10.78
12	3.4641	16.45	15.59	13.86	12.99	11.26
13	3.6056	17.13	16.22	14.42	13.52	11.72
14	3.7417	17.77	16.84	14.97	14.03	12.16
15	3.8730	18.40	17.43	15.49	14.52	12.59
16	4.0000	19.00	18.00	16.00	15.00	13.00
17	4.1231	19.58	18.55	16.49	15.46	13.40
18	4.2426	20.15	19.09	16.97	15.91	13.79
19	4.3589	20.70	19.62	17.44	16.35	14.17
20	4.4721	21.24	20.12	17.89	16.77	14.53
21	4.5826	21.77	20.62	18.33	17.18	14.89
22	4.6904	22.28	21.11	18.76	17.59	15.24
23	4.7958	22.78	21.58	19.18	17.98	15.59
24	4.8990	23.27	22.05	19.60	18.37	15.92
25	5.0000	23.75	22.50	20.00	18.75	16.25
26	5.0990	24.22	22.95	20.40	19.12	16.57
27	5.1962	24.68	23.38	20.78	19.49	16.89
28	5.2915	25.13	23.81	21.17	19.84	17.20
29	5.3852	25.58	24.23	21.54	20.19	17.50
30	5.4772	26.02	24.65	21.91	20.54	17.80
31	5.5678	26.45	25.05	22.27	20.88	18.10
32	5.6569	26.87	25.46	22.63	21.21	18.38
33	5.7446	27.29	25.85	22.98	21.54	18.67
34	5.8310	27.70	26.24	23.32	21.87	18.95
35	5.9161	28.10	26.62	23.66	22.19	19.23
36	6.0000	28.50	27.00	24.00	22.50	19.50
37	6.0828	28.89	27.37	24.33	22.81	19.77
38	6.1644	29.28	27.74	24.66	23.12	20.03
39	6.2450	29.66	28.10	24.98	23.42	20.30
40	6.3246	30.04	28.46	25.30	23.72	20.55
41	6.4031	30.41	28.81	25.61	24.01	20.81
42	6.4807	30.78	29.16	25.92	24.30	21.06
43	6.5574	31.15	29.51	26.23	24.59	21.31
44	6.6332	31.51	29.85	26.53	24.87	21.56
45	6.7082	31.86	30.19	26.83	25.16	21.80
46	6.7823	32.22	30.52	27.13	25.43	22.04
47	6.8557	32.56	30.85	27.42	25.71	22.28
48	6.9282	32.91	31.18	27.71	25.98	22.52
49	7.0000	33.25	31.50	28.00	26.25	22.75
50	7.0711	33.59	31.82	28.28	26.52	22.98
51	7.1414	33.92	32.14	28.57	26.78	23.21
52	7.2111	34.25	32.45	28.85	27.04	23.44
53	7.2801	34.58	32.76	29.12	27.30	23.66
54	7.3485	34.91	33.07	29.39	27.56	23.88
55	7.4162	35.23	33.37	29.66	27.81	24.10
56	7.4833	35.55	33.67	29.93	28.06	24.32
57	7.5498	35.86	33.97	30.20	28.31	24.54
58	7.6158	36.17	34.27	30.46	28.56	24.75
59	7.6811	36.49	34.57	30.72	28.80	24.96
60	7.7460	36.79	34.86	30.98	29.05	25.17
61	7.8102	37.10	35.15	31.24	29.29	25.38
62	7.8740	37.40	35.43	31.50	29.53	25.59
63	7.9373	37.70	35.72	31.75	29.76	25.80
64	8.0000	38.00	36.00	32.00	30.00	26.00
65	8.0623	38.30	36.28	32.25	30.23	26.20
66	8.1240	38.59	36.56	32.50	30.47	26.40
67	8.1854	38.88	36.83	32.74	30.70	26.60
68	8.2462	39.17	37.11	32.98	30.92	26.80
69	8.3066	39.46	37.38	33.23	31.15	27.00
70	8.3666	39.74	37.65	33.47	31.37	27.19

TWIST TABLE.

Counts or Numbers.	Square Root.	Ordinary Warp Twist.	Whitman's Warp Twist.	Extra Mule Warp Twist.	Mule Warp Twist.	Mule Filling Twist.
1	**1.0000**	**4.75**	**4.50**	**4.00**	**3.75**	**3.25**
71	8.4261	40.02	37.92	33.70	31.60	27.38
72	8.4853	40.31	38.18	33.94	31.82	27.58
73	8.5440	40.58	38.45	34.18	32.04	27.77
74	8.6023	40.86	38.71	34.41	32.26	27.96
75	8.6603	41.14	38.97	34.64	32.48	28.15
76	8.7178	41.41	39.23	34.87	32.69	28.33
77	8.7750	41.68	39.49	35.10	32.91	28.52
78	8.8318	41.95	39.74	35.33	33.12	28.70
79	8.8882	42.22	40.00	35.55	33.33	28.89
80	8.9443	42.49	40.25	35.78	33.54	29.07
81	9.0000	42.75	40.50	36.00	33.75	29.25
82	9.0554	43.01	40.75	36.22	33.96	29.43
83	9.1104	43.27	41.00	36.44	34.16	29.61
84	9.1652	43.53	41.24	36.66	34.37	29.79
85	9.2195	43.79	41.49	36.88	34.57	29.96
86	9.2736	44.05	41.73	37.09	34.78	30.14
87	9.3274	44.31	41.97	37.31	34.98	30.31
88	9.3808	44.56	42.21	37.52	35.18	30.49
89	9.4340	44.81	42.45	37.74	35.38	30.66
90	9.4868	45.06	42.69	37.95	35.58	30.83
91	9.5394	45.31	42.93	38.16	35.77	31.00
92	9.5917	45.56	43.16	38.37	35.97	31.17
93	9.6437	45.81	43.40	38.57	36.16	31.34
94	9.6954	46.05	43.63	38.78	36.36	31.51
95	9.7468	46.30	43.86	38.99	36.55	31.68
96	9.7980	46.54	44.09	39.19	36.74	31.84
97	9.8489	46.78	44.32	39.40	36.93	32.01
98	9.8995	47.02	44.55	39.60	37.12	32.17
99	9.9499	47.26	44.77	39.80	37.31	32.34
100	10.0000	47.50	45.00	40.00	37.50	32.50
101	10.0499	47.74	45.22	40.20	37.69	32.66
102	10.0995	47.97	45.45	40.40	37.87	32.82
103	10.1489	48.21	45.67	40.60	38.06	32.98
104	10.1980	48.44	45.89	40.79	38.24	33.14
105	10.2470	48.67	46.11	40.99	38.43	33.30
106	10.2956	48.90	46.33	41.18	38.61	33.46
107	10.3441	49.13	46.55	41.38	38.79	33.62
108	10.3973	49.36	46.77	41.57	38.97	33.77
109	10.4403	49.59	46.98	41.76	39.15	33.93
110	10.4881	49.82	47.20	41.95	39.33	34.09
111	10.5357	50.04	47.41	42.14	39.51	34.24
112	10.5830	50.27	47.62	42.33	39.69	34.39
113	10.6301	50.49	47.84	42.52	39.86	34.55
114	10.6771	50.72	48.05	42.71	40.04	34.70
115	10.7238	50.94	48.26	42.90	40.21	34.85
116	10.7703	51.16	48.47	43.08	40.39	35.00
117	10.8167	51.38	48.67	43.27	40.56	35.15
118	10.8628	51.60	48.88	43.45	40.74	35.30
119	10.9087	51.82	49.09	43.63	40.91	35.45
120	10.9545	52.03	49.30	43.82	41.08	35.60
121	11.0000	52.25	49.50	44.00	41.25	35.75
122	11.0454	52.47	49.70	44.18	41.42	35.90
123	11.0905	52.68	49.91	44.36	41.59	36.04
124	11.1355	52.89	50.11	44.54	41.73	36.19
125	11.1803	53.11	50.31	44.72	41.93	36.34
126	11.2250	53.32	50.51	44.90	42.09	36.48
127	11.2694	53.53	50.71	45.08	42.26	36.63
128	11.3137	53.74	50.91	45.25	42.43	36.77
129	11.3578	53.95	51.12	45.43	42.59	36.91
130	11.4018	54.16	51.31	45.61	42.76	37.06
131	11.4455	54.37	51.50	45.78	42.92	37.20
132	11.4891	54.57	51.70	45.96	43.08	37.34
133	11.5326	54.78	51.90	46.13	43.25	37.48
134	11.5758	54.99	52.09	46.30	43.41	37.62
135	11.6190	55.19	52.29	46.48	43.57	37.76
136	11.6619	55.39	52.48	46.65	43.73	37.90
137	11.7047	55.60	52.67	46.82	43.89	38.04
138	11.7473	55.80	52.86	47.99	44.05	38.18
139	11.7898	56.00	53.05	47.16	44.21	38.32
140	11.8322	56.20	53.24	47.33	44.37	38.45

TWO PLY.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by			No. of yarn to be twist'd	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by	
			4	5	6				5	6
1	.5	.7071	2.83	3.54	4.24	76	38.	6.1644	30.82	36.99
2	1.	1.	4.	5.	6.	77.	38.5	6.2049	31.02	37.23
3	1.5	1.2247	4.90	6.12	7.35	78	39.	6.2450	31.22	37.47
4	2.	1.4142	5.66	7.07	8.49	79	39.5	6.2849	31.42	37.71
5	2.5	1.5811	6.32	7.91	9.49	**80**	40.	6.3246	31.62	37.95
6	3.	1.7321	6.93	8.66	10.39	81	40.5	6.3640	31.82	38.18
7	3.5	1.8708	7.48	9.35	11.22	82	41.	6.4031	32.02	38.42
8	4.	2.	8.	10.	12.	83	41.5	6.4420	32.21	38.65
9	4.5	2.1213	8.49	10.61	12.73	84	42.	6.4807	32.40	38.88
10	5.	2.2361	8.94	11.18	13.42	85	42.5	6.5192	32.60	39.12
11	5.5	2.3452	9.38	11.73	14.07	86	43.	6.5574	32.79	39.34
12	6.	2.4495	9.80	12.25	14.70	87	43.5	6.5955	32.98	39.57
13	6.5	2.5495	10.20	12.75	15.30	88	44.	6.6332	33.17	39.80
14	7.	2.6458	10.58	13.23	15.87	89	44.5	6.6708	33.35	40.02
15	7.5	2.7386	10.95	13.69	16.43	**90**	45.	6.7082	33.54	40.25
16	8.	2.8284	11.31	14.14	16.97	91	45.5	6.7454	33.73	40.47
17	8.5	2.9155	11.66	14.58	17.49	92	46.	6.7823	33.91	40.69
18	9.	3.	12.	15.	18.	93	46.5	6.8191	34.10	40.91
19	9.5	3.0822	12.33	15.41	18.49	94	47.	6.8557	34.28	41.13
20	10.	3.1623	12.65	15.81	18.97	95	47.5	6.8920	34.46	41.35
21	10.5	3.2404	12.96	16.20	19.44	96	48.	6.9282	34.64	41.57
22	11.	3.3166	13.27	16.58	19.90	97	48.5	6.9642	34.82	41.79
23	11.5	3.3912	13.56	16.96	20.35	98	49.	7.	35.	42.
24	12.	3.4641	13.86	17.32	20.78	99	49.5	7.0356	35.18	42.21
25	12.5	3.5355	14.14	17.68	21.21	**100**	50.	7.0711	35.36	42.43
26	13.	3.6056	14.42	18.03	21.63	101	50.5	7.1063	35.53	42.64
27	13.5	3.6742	14.70	18.37	22.05	102	51.	7.1414	35.70	42.85
28	14.	3.7417	14.97	18.71	22.45	103	51.5	7.1763	35.88	43.06
29	14.5	3.8079	15.23	19.04	22.85	104	52.	7.2111	36.06	43.27
30	15.	3.8730	15.49	19.37	23.24	105	52.5	7.2457	36.23	43.47
31	15.5	3.9370	15.75	19.69	23.62	106	53.	7.2801	36.40	43.68
32	16.	4.	16.	20.	24.	107	53.5	7.3144	36.57	43.89
33	16.5	4.0620	16.25	20.31	24.37	108	54.	7.3485	36.74	44.09
34	17.	4.1231	16.49	20.62	24.74	109	54.5	7.3824	36.91	44.29
35	17.5	4.1833	16.73	20.92	25.10	**110**	55.	7.4162	37.08	44.50
36	18.	4.2426	16.97	21.21	25.46	111	55.5	7.4498	37.25	44.70
37	18.5	4.3012	17.20	21.51	25.81	112	56.	7.4833	37.42	44.90
38	19.	4.3589	17.44	21.79	26.15	113	56.5	7.5166	37.58	45.10
39	19.5	4.4159	17.66	22.08	26.50	114	57.	7.5498	37.75	45.30
40	20.	4.4721	17.89	22.36	26.83	115	57.5	7.5829	37.91	45.50
41	20.5	4.5277	18.11	22.64	27.17	116	58.	7.6158	38.08	45.69
42	21.	4.5826	18.33	22.91	27.50	117	58.5	7.6485	38.24	45.89
43	21.5	4.6368	18.55	23.18	27.82	118	59.	7.6811	38.41	46.09
44	22.	4.6904	18.76	23.45	28.14	119	59.5	7.7136	38.57	46.28
45	22.5	4.7434	18.97	23.72	28.46	**120**	60.	7.7460	38.73	46.48
46	23.	4.7958	19.18	23.98	28.77	121	60.5	7.7782	38.89	46.67
47	23.5	4.8477	19.39	24.24	29.09	122	61.	7.8102	39.05	46.86
48	24.	4.8990	19.60	24.49	29.39	123	61.5	7.8422	39.21	47.05
49	24.5	4.9497	19.80	24.75	29.70	124	62.	7.8740	39.37	47.24
50	25.	5.	20.	25.	30.	125	62.5	7.9057	39.53	47.43
51	25.5	5.0498	20.20	25.25	30.30	126	63.	7.9373	39.69	47.62
52	26.	5.0990	20.40	25.50	30.59	127	63.5	7.9687	39.84	47.81
53	26.5	5.1478	20.59	25.74	30.89	128	64.	8.	40.	48.
54	27.	5.1962	20.78	25.98	31.18	129	64.5	8.0312	40.16	48.19
55	27.5	5.2440	20.98	26.22	31.46	**130**	65.	8.0623	40.31	48.37
56	28.	5.2915	21.17	26.46	31.75	131	65.5	8.0932	40.47	48.56
57	28.5	5.3385	21.35	26.69	32.03	132	66.	8.1240	40.62	48.74
58	29.	5.3852	21.54	26.93	32.31	133	66.5	8.1548	40.77	48.93
59	29.5	5.4314	21.73	27.16	32.59	134	67.	8.1854	40.93	49.11
60	30.	5.4772	21.91	27.39	32.86	135	67.5	8.2158	41.08	49.30
61	30.5	5.5227	22.09	27.61	33.14	136	68.	8.2462	41.23	49.48
62	31.	5.5678	22.27	27.84	33.41	137	68.5	8.2765	41.38	49.66
63	31.5	5.6125	22.45	28.06	33.67	138	69.	8.3066	41.53	49.84
64	32.	5.6569	22.63	28.28	33.94	139	69.5	8.3367	41.68	50.02
65	32.5	5.7009	22.80	28.50	34.21	**140**	70.	8.3666	41.83	50.20
66	33.	5.7446	22.98	28.72	34.47	141	70.5	8.3964	41.98	50.38
67	33.5	5.7879	23.15	28.94	34.73	142	71.	8.4261	42.13	50.56
68	34.	5.8310	23.32	29.15	34.99	143	71.5	8.4558	42.28	50.73
69	34.5	5.8737	23.49	29.37	35.24	144	72.	8.4853	42.43	50.91
70	35.	5.9161	23.66	29.58	35.50	145	72.5	8.5147	42.57	51.09
71	35.5	5.9582	23.83	29.79	35.75	146	73.	8.5440	42.72	51.26
72	36.	6.	24.	30.	36.	147	73.5	8.5732	42.87	51.44
73	36.5	6.0415	24.17	30.21	36.25	148	74.	8.6023	43.01	51.61
74	37.	6.0828	24.33	30.41	36.50	149	74.5	8.6313	43.16	51.79
75	37.5	6.1237	24.49	30.62	36.74	**150**	75.	8.6603	43.30	51.96

THREE PLY.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by		
			4	5	6
1	.33	.5774	2.31	2.89	3.46
2	.67	.8165	3.27	4.08	4.90
3	1.	1.	4.	5.	6.
4	1.33	1.1547	4.62	5.77	6.93
5	1.67	1.2910	5.16	6.45	7.75
6	2.	1.4142	5.66	7.07	8.49
7	2.33	1.5275	6.11	7.64	9.17
8	2.67	1.6330	6.53	8.16	9.80
9	3.	1.7321	6.93	8.66	10.39
10	3.33	1.8257	7.30	9.13	10.95
11	3.67	1.9149	7.66	9.57	11.49
12	4.	2.	8.	10.	12.
13	4.33	2.0817	8.33	10.41	12.49
14	4.67	2.1602	8.64	10.80	12.96
15	5.	2.2361	8.94	11.18	13.42
16	5.33	2.3094	9.24	11.55	13.86
17	5.67	2.3805	9.52	11.90	14.28
18	6.	2.4495	9.80	12.25	14.70
19	6.33	2.5166	10.07	12.58	15.10
20	6.67	2.5820	10.33	12.91	15.49
21	7.	2.6458	10.58	13.23	15.87
22	7.33	2.7080	10.83	13.54	16.25
23	7.67	2.7689	11.08	13.84	16.61
24	8.	2.8284	11.31	14.14	16.97
25	8.33	2.8868	11.55	14.43	17.32
26	8.67	2.9439	11.76	14.72	17.66
27	9.	3.	12.	15.	18.
28	9.33	3.0551	12.22	15.28	18.33
29	9.67	3.1091	12.44	15.55	18.65
30	10.	3.1623	12.65	15.81	18.97
31	10.33	3.2145	12.86	16.07	19.29
32	10.67	3.2659	13.06	16.33	19.60
33	11.	3.3166	13.27	16.58	19.90
34	11.33	3.3665	13.47	16.83	20.20
35	11.67	3.4157	13.66	17.08	20.49
36	12.	3.4641	13.86	17.32	20.78
37	12.33	3.5119	14.05	17.56	21.07
38	12.67	3.5590	14.24	17.80	21.35
39	13.	3.6056	14.42	18.03	21.63
40	13.33	3.6515	14.61	18.26	21.91
41	13.67	3.6969	14.79	18.48	22.18
42	14.	3.7417	14.97	18.71	22.45
43	14.33	3.7859	15.14	18.93	22.72
44	14.67	3.8297	15.32	19.15	22.98
45	15.	3.8730	15.49	19.36	23.24
46	15.33	3.9158	15.66	19.58	23.49
47	15.67	3.9582	15.83	19.79	23.75
48	16.	4.	16.	20.	24.
49	16.33	4.0415	16.17	20.21	24.25
50	16.67	4.0825	16.33	20.41	24.49
51	17.	4.1231	16.49	20.62	24.74
52	17.33	4.1633	16.65	20.82	24.98
53	17.67	4.2032	16.81	21.02	25.22
54	18.	4.2426	16.97	21.21	25.46
55	18.33	4.2817	17.13	21.41	25.69
56	18.67	4.3205	17.28	21.60	25.92
57	19.	4.3589	17.44	21.79	26.15
58	19.33	4.3970	17.59	21.98	26.38
59	19.67	4.4347	17.74	22.17	26.61
60	20.	4.4721	17.89	22.36	26.83
61	20.33	4.5092	18.04	22.55	27.06
62	20.67	4.5461	18.18	22.73	27.28
63	21.	4.5826	18.33	22.91	27.50
64	21.33	4.6188	18.48	23.09	27.71
65	21.67	4.6547	18.62	23.27	27.93
66	22.	4.6904	18.76	23.45	28.14
67	22.33	4.7258	18.90	23.63	28.35
68	22.67	4.7610	19.04	23.80	28.57
69	23.	4.7958	19.18	23.98	28.77
70	23.33	4.8305	19.32	24.15	28.98
71	23.67	4.8648	19.46	24.32	29.19
72	24.	4.8990	19.60	24.49	29.39
73	24.33	4.9329	19.73	24.66	29.60
74	24.67	4.9666	19.87	24.83	29.80
75	25.	5.	20.	25.	30.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by	
			5	6
76	25.33	5.0332	25.17	30.20
77	25.67	5.0662	25.33	30.40
78	26.	5.0990	25.50	30.59
79	26.33	5.1316	25.66	30.79
80	26.67	5.1640	25.82	30.98
81	27.	5.1962	25.98	31.18
82	27.33	5.2281	26.14	31.37
83	27.67	5.2599	26.30	31.56
84	28.	5.2915	26.46	31.75
85	28.33	5.3229	26.61	31.94
86	28.67	5.3541	26.77	32.12
87	29.	5.3852	26.93	32.31
88	29.33	5.4160	27.08	32.50
89	29.67	5.4467	27.23	32.68
90	30.	5.4772	27.39	32.86
91	30.33	5.5076	27.54	33.05
92	30.67	5.5377	27.69	33.23
93	31.	5.5678	27.84	33.41
94	31.33	5.5976	27.99	33.59
95	31.67	5.6273	28.14	33.76
96	32.	5.6569	28.28	33.94
97	32.33	5.6862	28.43	34.12
98	32.67	5.7155	28.58	34.29
99	33.	5.7446	28.72	34.47
100	33.33	5.7735	28.87	34.64
101	33.67	5.8023	29.01	34.81
102	34.	5.8310	29.15	34.99
103	34.33	5.8595	29.30	35.16
104	34.67	5.8878	29.44	35.33
105	35.	5.9161	29.58	35.50
106	35.33	5.9442	29.72	35.67
107	35.67	5.9722	29.86	35.83
108	36.	6.	30.	36.
109	36.33	6.0277	30.14	36.17
110	36.67	6.0553	30.28	36.33
111	37.	6.0828	30.41	36.50
112	37.33	6.1101	30.55	36.66
113	37.67	6.1374	30.69	36.83
114	38.	6.1644	30.82	36.99
115	38.33	6.1914	30.96	37.15
116	38.67	6.2183	31.09	37.31
117	39.	6.2450	31.22	37.47
118	39.33	6.2716	31.36	37.63
119	39.67	6.2981	31.49	37.79
120	40.	6.3246	31.62	37.95
121	40.33	6.3509	31.75	38.11
122	40.67	6.3770	31.89	38.26
123	41.	6.4031	32.02	38.42
124	41.33	6.4291	32.15	38.57
125	41.67	6.4550	32.27	38.73
126	42.	6.4807	32.40	38.88
127	42.33	6.5064	32.53	39.04
128	42.67	6.5320	32.66	39.19
129	43.	6.5574	32.79	39.34
130	43.33	6.5828	32.91	39.50
131	43.67	6.6081	33.04	39.65
132	44.	6.6332	33.17	39.80
133	44.33	6.6583	33.29	39.95
134	44.67	6.6833	33.42	40.10
135	45.	6.7082	33.54	40.25
136	45.33	6.7330	33.67	40.40
137	45.67	6.7577	33.79	40.55
138	46.	6.7823	33.91	40.69
139	46.33	6.8069	34.03	40.84
140	46.67	6.8313	34.16	40.99
141	47.	6.8557	34.28	41.13
142	47.33	6.8799	34.40	41.28
143	47.67	6.9041	34.52	41.42
144	48.	6.9282	34.64	41.57
145	48.33	6.9522	34.76	41.71
146	48.67	6.9762	34.88	41.86
147	49.	7.	35.	42.
148	49.33	7.0238	35.12	42.14
149	49.67	7.0475	35.24	42.28
150	50.	7.0711	35.36	42.43

FOUR PLY.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by			No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by	
			4	5	6				5	6
1	.25	.5	2.	2.5	3.	76	19.	4.3589	21.79	26.15
2	.50	.7071	2.83	3.54	4.24	77	.25	4.3875	21.94	26.32
3	.75	.8660	3.46	4.33	5.20	78	.50	4.4159	22.08	26.50
4	1.	1.	4.	5.	6.	79	.75	4.4441	22.22	26.66
5	.25	1.1180	4.47	5.59	6.71	**80**	20.	4.4721	22.36	26.83
6	.50	1.2247	4.90	6.12	7.35	81	.25	4.5	22.5	27.
7	.75	1.3229	5.29	6.61	7.94	82	.50	4.5277	22.64	27.17
8	2.	1.4142	5.66	7.07	8.49	83	.75	4.5552	22.78	27.33
9	.25	1.5	6.	7.5	9.	84	21.	4.5826	22.91	27.50
10	.50	1.5811	6.32	7.91	9.49	85	.25	4.6098	23.05	27.66
11	.75	1.6583	6.63	8.29	9.95	86	.50	4.6368	23.18	27.82
12	3.	1.7321	6.93	8.66	10.39	87	.75	4.6637	23.32	27.98
13	.25	1.8028	7.21	9.01	10.82	88	22.	4.6904	23.45	28.14
14	.50	1.8708	7.48	9.35	11.22	89	.25	4.7170	23.58	28.30
15	.75	1.9365	7.75	9.68	11.62	**90**	.50	4.7434	23.72	28.46
16	4.	2.	8.	10.	12.	91	.75	4.7697	23.85	28.62
17	.25	2.0616	8.25	10.31	12.37	92	23.	4.7958	23.98	28.77
18	.50	2.1213	8.49	10.61	12.73	93	.25	4.8218	24.11	28.93
19	.75	2.1794	8.72	10.90	13.08	94	.50	4.8477	24.24	29.09
20	5.	2.2361	8.94	11.18	13.42	95	.75	4.8734	24.37	29.24
21	.25	2.2913	9.17	11.46	13.75	96	24.	4.8990	24.49	29.39
22	.50	2.3452	9.38	11.73	14.07	97	.25	4.9244	24.62	29.55
23	.75	2.3979	9.59	11.99	14.39	98	.50	4.9497	24.75	29.70
24	6.	2.4495	9.80	12.25	14.70	99	.75	4.9749	24.87	29.85
25	.25	2.5	10.	12.5	15.	**100**	25.	5.	25.	30.
26	.50	2.5495	10.20	12.75	15.30	101	.25	5.0249	25.12	30.15
27	.75	2.5981	10.39	12.99	15.59	102	.50	5.0498	25.25	30.30
28	7.	2.6458	10.58	13.23	15.87	103	.75	5.0744	25.37	30.45
29	.25	2.6926	10.77	13.46	16.16	104	26.	5.0990	25.50	30.59
30	.50	2.7386	10.95	13.69	16.43	105	.25	5.1235	25.62	30.74
31	.75	2.7839	11.14	13.92	16.70	106	.50	5.1478	25.74	30.89
32	8.	2.8284	11.31	14.14	16.97	107	.75	5.1720	25.86	31.03
33	.25	2.8723	11.49	14.36	17.23	108	27.	5.1962	25.98	31.18
34	.50	2.9155	11.66	14.58	17.49	109	.25	5.2202	26.10	31.32
35	.75	2.9580	11.83	14.79	17.75	**110**	.50	5.2440	26.22	31.46
36	9.	3.	12.	15.	18.	111	.75	5.2678	26.34	31.61
37	.25	3.0414	12.17	15.21	18.25	112	28.	5.2915	26.46	31.75
38	.50	3.0822	12.33	15.41	18.49	113	.25	5.3151	26.58	31.89
39	.75	3.1225	12.49	15.61	18.73	114	.50	5.3385	26.69	32.03
40	10.	3.1623	12.65	15.81	18.97	115	.75	5.3619	26.81	32.17
41	.25	3.2016	12.81	16.01	19.21	116	29.	5.3852	26.93	32.31
42	.50	3.2404	12.96	16.20	19.44	117	.25	5.4083	27.04	32.45
43	.75	3.2787	13.11	16.39	19.67	118	.50	5.4314	27.16	32.59
44	11.	3.3166	13.27	16.58	19.90	119	.75	5.4543	27.27	32.73
45	.25	3.3541	13.42	16.77	20.12	**120**	30.	5.4772	27.39	32.86
46	.50	3.3912	13.56	16.96	20.35	121	.25	5.5	27.5	33.
47	.75	3.4278	13.71	17.14	20.57	122	.50	5.5227	27.61	33.14
48	12.	3.4641	13.86	17.32	20.78	123	.75	5.5453	27.73	33.27
49	.25	3.5	14.	17.5	21.	124	31.	5.5678	27.84	33.41
50	.50	3.5355	14.14	17.68	21.21	125	.25	5.5902	27.95	33.54
51	.75	3.5707	14.28	17.85	21.42	126	.50	5.6125	28.06	33.67
52	13.	3.6056	14.42	18.03	21.63	127	.75	5.6347	28.17	33.81
53	.25	3.6401	14.56	18.20	21.84	128	32.	5.6569	28.28	33.94
54	.50	3.6742	14.70	18.37	22.05	129	.25	5.6789	28.39	34.07
55	.75	3.7081	14.83	18.54	22.25	**130**	.50	5.7009	28.50	34.21
56	14.	3.7417	14.97	18.71	22.45	131	.75	5.7228	28.61	34.34
57	.25	3.7749	15.10	18.87	22.65	132	33.	5.7446	28.72	34.47
58	.50	3.8079	15.23	19.04	22.85	133	.25	5.7663	28.83	34.60
59	.75	3.8406	15.36	19.20	23.04	134	.50	5.7879	28.94	34.73
60	15.	3.8730	15.49	19.37	23.24	135	.75	5.8095	29.05	34.86
61	.25	3.9051	15.62	19.53	23.43	136	34.	5.8310	29.15	34.99
62	.50	3.9370	15.75	19.69	23.62	137	.25	5.8524	29.26	35.11
63	.75	3.9686	15.88	19.84	23.81	138	.50	5.8737	29.37	35.24
64	16.	4.	16.	20.	24.	139	.75	5.8949	29.47	35.37
65	.25	4.0311	16.12	20.16	24.19	**140**	35.	5.9161	29.58	35.50
66	.50	4.0620	16.25	20.31	24.37	141	.25	5.9372	29.69	35.62
67	.75	4.0927	16.37	20.46	24.56	142	.50	5.9582	29.79	35.75
68	17.	4.1231	16.49	20.62	24.74	143	.75	5.9791	29.90	35.87
69	.25	4.1533	16.61	20.77	24.92	144	36.	6.	30.	36.
70	.50	4.1833	16.73	20.92	25.10	145	.25	6.0208	30.10	36.12
71	.75	4.2130	16.85	21.07	25.28	146	.50	6.0415	30.21	36.25
72	18.	4.2426	16.97	21.21	25.46	147	.75	6.0622	30.31	36.37
73	.25	4.2720	17.09	21.36	25.63	148	37.	6.0828	30.41	36.50
74	.50	4.3012	17.20	21.51	25.81	149	.25	6.1033	30.52	36.62
75	.75	4.3301	17.32	21.65	25.98	**150**	.50	6.1237	30.62	36.74

FIVE PLY.

No. of yarn to be twist'd	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by			No. of yarn to be twist'd.	No of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by	
			4	5	6				5	6
1	**2**	.4472	1.79	2.24	2.68	**76**	15.2	3.8987	19.49	23.39
2	.4	.6325	2.53	3.16	3.79	77	.4	3.9243	19.62	23.55
3	.6	.7746	3.10	3.87	4.65	78	.6	3.9497	19.75	23.70
4	.8	.8944	3.58	4.47	5.37	79	.8	3.9749	19.87	23.85
5	1.	1.	4.	5.	6.	**80**	16.	4.	20.	24.
6	.2	1.0954	4.38	5.48	6.57	81	.2	4.0249	20.12	24.15
7	.4	1.1832	4.73	5.92	7.10	82	.4	4.0497	20.25	24.30
8	.6	1.2649	5.06	6.32	7.59	83	.6	4.0743	20.37	24.45
9	.8	1.3416	5.37	6.71	8.05	84	.8	4.0988	20.49	24.59
10	2.	1.4142	5.66	7.07	8.49	85	17.	4.1231	20.62	24.74
11	.2	1.4832	5.93	7.42	8.90	86	.2	4.1473	20.74	24.88
12	.4	1.5492	6.20	7.75	9.30	87	.4	4.1713	20.86	25.03
13	.6	1.6125	6.45	8.06	9.67	88	.6	4.1952	20.98	25.17
14	.8	1.6733	6.69	8.37	10.04	89	.8	4.2190	21.10	25.31
15	3.	1.7321	6.93	8.66	10.39	**90**	18.	4.2426	21.21	25.46
16	.2	1.7889	7.16	8.95	10.73	91	.2	4.2661	21.33	25.60
17	.4	1.8439	7.38	9.22	11.06	92	.4	4.2895	21.45	25.74
18	.6	1.8974	7.59	9.49	11.38	93	.6	4.3128	21.56	25.88
19	.8	1.9494	7.80	9.75	11.70	94	.8	4.3359	21.68	26.02
20	4.	2.	8.	10.	12.	95	19.	4.3589	21.79	26.15
21	.2	2.0494	8.20	10.25	12.30	96	.2	4.3818	21.91	26.29
22	.4	2.0976	8.39	10.49	12.59	97	.4	4.4045	22.02	26.43
23	.6	2.1448	8.58	10.72	12.87	98	.6	4.4272	22.14	26.56
24	.8	2.1909	8.76	10.95	13.15	99	.8	4.4497	22.25	26.70
25	5.	2.2361	8.94	11.18	13.42	**100**	20.	4.4721	22.36	26.83
26	.2	2.2804	9.12	11.40	13.68	101	.2	4.4944	22.47	26.97
27	.4	2.3238	9.30	11.62	13.94	102	.4	4.5166	22.58	27.10
28	.6	2.3664	9.47	11.83	14.20	103	.6	4.5387	22.69	27.23
29	.8	2.4083	9.63	12.04	14.45	104	.8	4.5607	22.80	27.36
30	6.	2.4495	9.80	12.25	14.70	105	21.	4.5826	22.91	27.50
31	.2	2.4900	9.96	12.45	14.94	106	.2	4.6043	23.02	27.63
32	.4	2.5298	10.12	12.65	15.18	107	.4	4.6260	23.13	27.76
33	.6	2.5690	10.28	12.85	15.41	108	.6	4.6476	23.24	27.89
34	.8	2.6077	10.43	13.04	15.65	109	.8	4.6690	23.35	28.01
35	7.	2.6458	10.58	13.23	15.87	**110**	22.	4.6904	23.45	28.14
36	.2	2.6833	10.73	13.42	16.10	111	.2	4.7117	23.56	28.27
37	.4	2.7203	10.88	13.60	16.32	112	.4	4.7329	23.66	28.40
38	.6	2.7568	11.03	13.78	16.54	113	.6	4.7539	23.77	28.52
39	.8	2.7928	11.17	13.96	16.76	114	.8	4.7749	23.87	28.65
40	8.	2.8284	11.31	14.14	16.97	115	23.	4.7958	23.98	28.77
41	.2	2.8636	11.45	14.32	17.18	116	.2	4.8166	24.08	28.90
42	.4	2.8983	11.59	14.49	17.39	117	.4	4.8374	24.19	29.02
43	.6	2.9326	11.73	14.66	17.60	118	.6	4.8580	24.29	29.15
44	.8	2.9665	11.87	14.83	17.80	119	.8	4.8785	24.39	29.27
45	9.	3.	12.	15.	18.	**120**	24.	4.8990	24.49	29.39
46	.2	3.0332	12.13	15.17	18.20	121	.2	4.9193	24.60	29.52
47	.4	3.0659	12.26	15.33	18.40	122	.4	4.9396	24.70	29.64
48	.6	3.0984	12.39	15.49	18.59	123	.6	4.9598	24.80	29.76
49	.8	3.1305	12.52	15.65	18.78	124	.8	4.9800	24.90	29.88
50	10.	3.1623	12.65	15.81	18.97	125	25.	5.	25.	30.
51	.2	3.1937	12.77	15.97	19.16	126	.2	5.0200	25.10	30.12
52	.4	3.2249	12.90	16.12	19.35	127	.4	5.0398	25.20	30.24
53	.6	3.2558	13.02	16.28	19.53	128	.6	5.0596	25.30	30.36
54	.8	3.2863	13.15	16.43	19.72	129	.8	5.0794	25.40	30.48
55	11.	3.3166	13.27	16.58	19.90	**130**	26.	5.0990	25.50	30.59
56	.2	3.3466	13.39	16.73	20.08	131	.2	5.1186	25.59	30.71
57	.4	3.3764	13.51	16.88	20.26	132	.4	5.1381	25.69	30.83
58	.6	3.4059	13.62	17.03	20.44	133	.6	5.1575	25.79	30.95
59	.8	3.4351	13.74	17.18	20.61	134	.8	5.1769	25.88	31.06
60	12.	3.4641	13.86	17.32	20.78	135	27.	5.1962	25.98	31.18
61	.2	3.4928	13.97	17.46	20.96	136	.2	5.2154	26.08	31.29
62	.4	3.5214	14.09	17.61	21.13	137	.4	5.2345	26.17	31.41
63	.6	3.5496	14.20	17.75	21.30	138	.6	5.2536	26.27	31.52
64	.8	3.5777	14.31	17.89	21.47	139	.8	5.2726	26.36	31.64
65	13.	3.6056	14.42	18.03	21.63	**140**	28.	5.2915	26.46	31.75
66	.2	3.6332	14.53	18.17	21.80	141	.2	5.3104	26.55	31.86
67	.4	3.6606	14.64	18.30	21.96	142	.4	5.3292	26.65	31.97
68	.6	3.6878	14.75	18.44	22.13	143	.6	5.3479	26.74	32.09
69	.8	3.7148	14.86	18.57	22.29	144	.8	5.3666	26.83	32.20
70	14.	3.7417	14.97	18.71	22.45	145	29.	5.3852	26.93	32.31
71	.2	3.7683	15.07	18.84	22.61	146	.2	5.4037	27.02	32.42
72	.4	3.7947	15.18	18.97	22.77	147	.4	5.4222	27.11	32.53
73	.6	3.8210	15.28	19.10	22.93	148	.6	5.4406	27.20	32.64
74	.8	3.8471	15.38	19.24	23.08	149	.8	5.4589	27.29	32.75
75	15.	3.8730	15.49	19.37	23.24	**150**	30.	5.4772	27.39	32.86

SIX PLY.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by			No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by	
			4	5	6				5	6
1	.17	.4082	1.63	2.04	2.45	76	12.67	3.5590	17.80	21.35
2	.33	.5774	2.31	2.89	3.46	77	.83	3.5824	17.91	21.49
3	.50	.7071	2.83	3.54	4.24	78	13.	3.6056	18.03	21.63
4	.67	.8165	3.27	4.08	4.90	79	.17	3.6286	18.14	21.77
5	.83	.9129	3.65	4.56	5.48	**80**	.33	3.6515	18.26	21.91
6	1.	1.	4.	5.	6.	81	.50	3.6742	18.37	22.05
7	.17	1.0801	4.32	5.40	6.48	82	.67	3.6969	18.48	22.18
8	.33	1.1547	4.62	5.77	6.93	83	.83	3.7192	18.60	22.32
9	.50	1.2247	4.90	6.12	7.35	84	14.	3.7417	18.71	22.45
10	.67	1.2910	5.16	6.45	7.75	85	.17	3.7639	18.82	22.58
11	.83	1.3540	5.42	6.77	8.12	86	.33	3.7859	18.93	22.72
12	2.	1.4142	5.66	7.07	8.49	87	.50	3.8079	19.04	22.85
13	.17	1.4720	5.89	7.36	8.83	88	.67	3.8297	19.15	22.98
14	.33	1.5275	6.11	7.64	9.17	89	.83	3.8514	19.26	23.11
15	.50	1.5811	6.32	7.91	9.49	**90**	15.	3.8730	19.36	23.24
16	.67	1.6330	6.53	8.16	9.80	91	.17	3.8944	19.47	23.37
17	.83	1.6833	6.73	8.42	10.10	92	.33	3.9158	19.58	23.49
18	3.	1.7321	6.93	8.66	10.39	93	.50	3.9370	19.69	23.62
19	.17	1.7795	7.12	8.90	10.68	94	.67	3.9582	19.79	23.75
20	.33	1.8257	7.30	9.13	10.95	95	.83	3.9791	19.90	23.87
21	.50	1.8708	7.48	9.35	11.22	96	16.	4.	20.	24.
22	.67	1.9149	7.66	9.57	11.49	97	.17	4.0208	20.10	24.12
23	.83	1.9579	7.83	9.79	11.75	98	.33	4.0415	20.21	24.25
4.	2.		8.	10.	12.	99	.50	4.0620	20.31	24.37
25	.17	2.0412	8.16	10.21	12.25	**100**	.67	4.0825	20.41	24.49
26	.33	2.0817	8.33	10.41	12.49	101	.83	4.1028	20.51	24.62
27	.50	2.1213	8.49	10.61	12.73	102	17.	4.1231	20.62	24.74
28	.67	2.1602	8.64	10.80	12.96	103	.17	4.1433	20.72	24.86
29	.83	2.1985	8.79	10.99	13.19	104	.33	4.1633	20.82	24.98
30	5.	2.2361	8.94	11.18	13.42	105	.50	4.1833	20.92	25.10
31	.17	2.2730	9.09	11.37	13.64	106	.67	4.2032	21.02	25.22
32	.33	2.3094	9.24	11.55	13.86	107	.83	4.2229	21.11	25.34
33	.50	2.3452	9.38	11.73	14.07	108	18.	4.2426	21.21	25.46
34	.67	2.3805	9.52	11.90	14.28	109	.17	4.2622	21.31	25.57
35	.83	2.4152	9.66	12.08	14.49	**110**	.33	4.2817	21.41	25.69
36	6.	2.4495	9.80	12.25	14.70	111	.50	4.3012	21.51	25.81
37	.17	2.4833	9.93	12.42	14.90	112	.67	4.3205	21.60	25.92
38	.33	2.5166	10.07	12.58	15.10	113	.83	4.3397	21.70	26.04
39	.50	2.5495	10.20	12.75	15.30	114	19.	4.3589	21.79	26.15
40	.67	2.5820	10.53	12.91	15.49	115	.17	4.3780	21.89	26.27
41	.83	2.6141	10.46	13.07	15.68	116	.33	4.3970	21.98	26.38
42	7.	2.6458	10.58	13.23	15.87	117	.50	4.4159	22.08	26.50
43	.17	2.6771	10.71	13.39	16.06	118	.67	4.4347	22.17	26.61
44	.33	2.7080	10.83	13.54	16.25	119	.83	4.4535	22.27	26.72
45	.50	2.7386	10.95	13.69	16.43	**120**	20.	4.4721	22.36	26.83
46	.67	2.7689	11.08	13.84	16.61	121	.17	4.4907	22.45	26.94
47	.83	2.7988	11.20	13.99	16.79	122	.33	4.5092	22.55	27.06
48	8.	2.8284	11.31	14.14	16.97	123	.50	4.5277	22.64	27.17
49	.17	2.8577	11.43	14.29	17.15	124	.67	4.5461	22.73	27.28
50	.33	2.8868	11.55	14.43	17.32	125	.83	4.5644	22.82	27.39
51	.50	2.9155	11.66	14.58	17.49	126	21.	4.5826	22.91	27.50
52	.67	2.9439	11.78	14.72	17.66	127	.17	4.6007	23.00	27.60
53	.83	2.9721	11.89	14.86	17.83	128	.33	4.6188	23.09	27.71
54	9.	3.	12.	15.	18.	129	.50	4.6368	23.18	27.82
55	.17	3.0277	12.11	15.14	18.17	**130**	.67	4.6547	23.27	27.93
56	.33	3.0551	12.22	15.28	18.33	131	.83	4.6726	23.36	28.04
57	.50	3.0822	12.33	15.41	18.49	132	22.	4.6904	23.45	28.14
58	.67	3.1091	12.44	15.55	18.65	133	.17	4.7081	23.54	28.25
59	.83	3.1358	12.54	15.68	18.81	134	.33	4.7258	23.63	28.35
60	10.	3.1623	12.65	15.81	18.97	135	.50	4.7434	23.72	28.46
61	.17	3.1885	12.75	15.94	19.13	136	.67	4.7610	23.80	28.57
62	.33	3.2145	12.86	16.07	19.29	137	.83	4.7784	23.89	28.67
63	.50	3.2404	12.96	16.20	19.44	138	23.	4.7958	23.98	28.77
64	.67	3.2659	13.06	16.33	19.60	139	.17	4.8132	24.07	28.88
65	.83	3.2914	13.17	16.46	19.75	**140**	.33	4.8305	24.15	28.98
66	11.	3.3166	13.27	16.58	19.90	141	.50	4.8477	24.24	29.09
67	.17	3.3417	13.37	16.71	20.05	142	.67	4.8648	24.32	29.19
68	.33	3.3665	13.47	16.83	20.20	143	.83	4.8819	24.41	29.29
69	.50	3.3912	13.56	16.96	20.35	144	24.	4.8990	24.49	29.39
70	.67	3.4157	13.66	17.08	20.49	145	.17	4.9160	24.58	29.50
71	.83	3.4400	13.76	17.20	20.64	146	.33	4.9329	24.66	29.60
72	12.	3.4641	13.86	17.32	20.78	147	.50	4.9497	24.75	29.70
73	.17	3.4881	13.95	17.44	20.93	148	.67	4.9666	24.83	29.80
74	.33	3.5119	14.05	17.56	21.07	149	.83	4.9833	24.92	29.90
75	.50	3.5355	14.14	17.68	21.21	**150**	25.	5.	25.	30.

WEAVING.

Our general comments on the weave-room will be found in our data relating to the Northrop loom, both in this book and in our regular loom catalogue entitled "Labor Saving Looms." The weave-room covers so many possible combinations in machine and product, that there are few general statements that may be made. Looms endeavor to perform so many unmechanical operations, that they do not fall within the ordinary class of machine, and the shop trained mechanic or engineering expert would find "fixing" an impossible immediate task, his varied experience in other lines being worthless in this special sphere. We are doing our best to eliminate the curious make-shifts which have been on duty for so long a time that they receive an almost superstitious reverence.

The weave-room presents the most notable instance of piece payment in the cotton mill system, and also the chief instance of personal responsibility for defect in product. The help are responsible for more strikes than in any other department outside the mule-room. Any invention or process that reduces the number of laborers employed in this section is worthy immediate investigation.

The fact that the weaver must rely on the efforts of another laborer, to keep the machinery up to its best efficiency, also complicates the problem of management. American cotton mills are continually forced into additional complications by the requirements of more varied weaves, the curious insistence of style calling for continual changes in patterns. The Jacquard motion, the Dobby and various other attachments are getting more common, and the skill and experience of the operative must necessarily assume a higher plane, in conformity to new requirements.

We make no attempt to touch upon the various points involved in fancy weaves, as the limits of the present volume are too narrow. Much of the necessary education, and by far the better part, must come from actual experience. Reference to the problems introduced by automatic weaving will be found elsewhere.

RULES AND INFORMATION FOR WEAVERS.

To find the number of yards of cloth to the pound avoirdupois:

Multiply its width in inches by the weight in grains of a piece containing 1 square inch; divide 194.44 by the product and the quotient will be the number of yards to the pound. *Example:* Width of cloth, 30 inches; weight of 1 square inch, 1.5 grains. $\frac{194.44}{30\times1.5}$=4.32 yards per pound.

To find the average number of yarn required to produce cloth of any desired weight, width, and pick:

Add together the number of picks per inch of warp and filling; multiply their sum by the yards of cloth per pound, and this product by the width in inches; divide by 840, and the quotient will be the average number of yarn required. For any increase in weight by sizing, proportional allowance must be made in the yarn.

N. B.—As the filling is taken up in crossing the warp, and the amount varies in different goods, this rule is not exact, but will approximate near enough to furnish a basis for practical purposes.

Weight of a square yard of cloth when the weight of a square inch is given:

Weight of sq. in. in grains.	1	2	3	4	5	6	7
Weight of sq. yd. in lbs.	.1851	.3703	.5554	.7406	.9257	1.1109	1.2961

To find the size of warp of filling in any piece of goods:

Take 8 or more threads of any known number, say 2 feet long, and tie the ends together; this makes a link, through which draw the same number of threads of the same length of the unknown number, and twist the two links thus made as you would twist a chain. A keen eye will detect any difference in the size of the two links. By adding to or taking from either link, they can be varied in size in proportion to the number of threads used, and brought to nearly equal each other. When as nearly as possible alike, the unknown number can be approximately determined by the proportionate number of strands in each link. Thus, if 28 is the known number, and if 7 strands of the unknown make an equal size link of 8 strands of the known, the number of the unknown will be $\frac{7}{8}$ of 28=24.5.

Cotton cloth is sold on a basis of a certain number of yards to the pound, with a certain number of picks or threads per inch in warp and filling.

Standard print cloths weigh seven yards to the pound, have 64 picks of warp and filling to the inch, and are called 64×64—seven-yard goods.

Loom reeds are numbered by the number of dents or splits to the inch.

The number of threads in a warp divided by the number of the reed multiplied by the width in inches, will give the number of threads in a dent.

Linens take their technical fineness from the number of hundred dents or splits in a loom reed thirty-seven inches wide. There are two threads to each dent. The following table, adapted from Barlow's "History of Weaving," gives the number of threads to the inch for each "count" of linen goods:

Hundreds.	Threads per inch.	Hundreds.	Threads per inch.	Hundreds.	Threads per inch.	Hundreds.	Threads per inch
5 00	27.03	12 00	64.86	19 00	102.7	26 00	140.5
6 00	32.43	13 00	70.27	20 00	108.1	27 00	145.9
7 00	37.84	14 00	75.68	21 00	113.5	28 00	151.4
8 00	43.24	15 00	81.08	22 00	118.9	29 00	156.8
9 00	48.65	16 00	86.49	23 00	124.3	30 00	162.2
10 00	54.05	17 00	91.89	24 00	129.7	31 00	167.6
11 00	59.46	18 00	97.30	25 00	135.1	32 00	173.0

Weight of warp or filling in one square yard:

The tables on pages 96–99 give the weight in decimals of a pound of the quantity of common warp and weft or filling in one square yard of cloth for any number of yarn, from five to one hundred, and for any number of picks per inch from twenty to one hundred and eighty. Multiply the weight given in the tables by .525 for woolen, 1.5 for worsted, 2.8 for linen and .525 for silk, if the number of the silk represents the number of hundred yards per ounce.

Both warp and filling take up in weaving, by passing over and under alternate threads; therefore, one yard of warp or filling will fall a percentage short of making a yard of cloth. This percentage varies with each different size of yarn and number of picks per inch, and for other reasons; consequently, the tables have been made, giving the weights of straight yarn, to which must be added the take-up or shrinkage, to obtain the precise weight of a yard of cloth. It may be safe to say that from seven to eight per cent. is an average shrinkage on cotton goods. On some woolen cloths, the finishing processes reduce the weight so that the calculated weights are as near as may be to the weight of the finished goods.

Yarn is commonly numbered before it is slashed or sized, and in estimating the weight of finished cloth, the quantity of sizing added to the warp must be known.

Production in yards of a loom running constantly for ten hours:

The tables on pages 100–101 give the number of yards of cloth which can be woven per loom in one day of ten hours, if the loom runs constantly. If the quantity given in the tables is exceeded in the production of any loom, it shows that an error has been made in estimating the number of picks per inch or in the speed of the loom. Of course, the same errors might account for a falling *short* of the quantities in the table; but as no loom runs constantly, the difference between the actual production and the possible production, represents the quantity that might be woven during the time that the loom is stopped. The percentage of time of stoppage of a loom can be ascertained by dividing this difference by the possible production.

The following tables were prepared by Mr. Richards of the Maginnis Cotton Mills of New Orleans.

No. of yarn.	Picks per inch.									
	20	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
5	.171	.180	.189	.197	.206	.214	.223	.231	.240	.249
6	.143	.150	.157	.164	.171	.179	.186	.193	.200	.207
7	.122	.129	.135	.141	.147	.153	.159	.165	.171	.178
8	.107	.112	.118	.123	.129	.134	.139	.145	.150	.155
9	.095	.100	.105	.110	.114	.119	.124	.129	.133	.138
10	.086	.090	.094	.099	.103	.107	.111	.116	.120	.124
11	.078	.082	.086	.090	.094	.097	.101	.105	.109	.113
12	.071	.075	.079	.082	.086	.089	.093	.096	.100	.104
13	.066	.069	.073	.076	.079	.082	.086	.089	.092	.096
14	.061	.064	.067	.070	.073	.077	.080	.083	.086	.089
15	.057	.060	.063	.066	.069	.071	.074	.077	.080	.083
16	.054	.056	.059	.062	.064	.067	.070	.072	.075	.078
17	.050	.053	.055	.058	.060	.063	.066	.068	.071	.073
18	.048	.050	.052	.055	.057	.060	.062	.064	.067	.069
19	.045	.047	.050	.052	.054	.056	.059	.061	.063	.065
20	.043	.045	.047	.049	.051	.054	.056	.058	.060	.062
21	.041	.043	.045	.047	.049	.051	.053	.055	.057	.059
22	.039	.041	.043	.045	.047	.049	.051	.053	.055	.056
23	.037	.039	.041	.043	.045	.047	.048	.050	.052	.054
24	.036	.037	.039	.041	.043	.045	.046	.048	.050	.052
25	.034	.036	.038	.039	.041	.043	.045	.046	.048	.050
26	.033	.035	.036	.038	.040	.041	.043	.045	.046	.048
27	.032	.033	.035	.037	.038	.040	.041	.043	.044	.046
28	.031	.032	.034	.035	.037	.038	.040	.041	.043	.044
29	.030	.031	.032	.034	.035	.037	.038	.040	.041	.043
30	.029	.030	.031	.033	.034	.036	.037	.039	.040	.041
31	.028	.029	.030	.032	.033	.035	.036	.037	.039	.040
32	.027	.028	.029	.031	.032	.033	.035	.036	.037	.039
33	.026	.027	.029	.030	.031	.032	.034	.035	.036	.038
34	.025	.026	.028	.029	.030	.032	.033	.034	.035	.037
35	.024	.026	.027	.028	.029	.031	.032	.033	.034	.036
36	.024	.025	.026	.027	.029	.030	.031	.032	.033	.035
37	.023	.024	.025	.027	.028	.029	.030	.031	.032	.034
38	.023	.024	.025	.026	.027	.028	.029	.030	.032	.033
39	.022	.023	.024	.025	.026	.027	.029	.030	.031	.032
40	.021	.022	.024	.025	.026	.027	.028	.029	.030	.031
	30	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**
5	.257	.266	.274	.283	.291	.300	.309	.317	.326	.334
6	.214	.221	.229	.236	.243	.250	.257	.264	.271	.279
7	.184	.190	.196	.202	.208	.214	.220	.227	.233	.239
8	.161	.166	.171	.177	.182	.187	.193	.197	.204	.209
9	.143	.148	.152	.157	.162	.167	.171	.176	.181	.186
10	.129	.133	.137	.141	.146	.150	.154	.159	.163	.167
11	.117	.121	.125	.129	.132	.136	.140	.144	.148	.152
12	.107	.111	.114	.118	.121	.125	.129	.132	.136	.139
13	.099	.102	.105	.109	.112	.115	.119	.122	.125	.129
14	.092	.095	.098	.101	.104	.107	.110	.113	.116	.119
15	.086	.089	.091	.094	.097	.100	.103	.106	.109	.111
16	.080	.083	.086	.088	.091	.094	.096	.099	.102	.104
17	.076	.078	.081	.083	.086	.088	.091	.093	.096	.098
18	.071	.074	.076	.079	.081	.083	.086	.088	.090	.093
19	.068	.070	.072	.074	.077	.079	.081	.083	.086	.088
20	.064	.066	.069	.071	.073	.075	.077	.079	.081	.084
21	.061	.063	.065	.067	.069	.071	.073	.076	.078	.080
22	.058	.060	.062	.064	.066	.068	.070	.072	.074	.076
23	.056	.058	.060	.061	.063	.065	.067	.069	.071	.073
24	.054	.055	.057	.059	.061	.062	.064	.066	.068	.070
25	.051	.053	.055	.057	.058	.060	.062	.063	.065	.067
26	.049	.051	.053	.054	.056	.058	.059	.061	.063	.064
27	.048	.049	.051	.052	.054	.056	.057	.059	.060	.062
28	.046	.047	.049	.051	.052	.054	.055	.057	.058	.060
29	.044	.046	.047	.049	.050	.052	.053	.055	.056	.058
30	.043	.044	.046	.047	.049	.050	.051	.053	.054	.056
31	.041	.043	.044	.046	.047	.048	.050	.051	.052	.054
32	.040	.042	.043	.044	.046	.047	.048	.050	.051	.052
33	.039	.040	.042	.043	.044	.045	.047	.048	.049	.051
34	.038	.039	.040	.042	.043	.044	.045	.047	.048	.049
35	.037	.038	.039	.040	.042	.043	.044	.045	.046	.048
36	.036	.037	.038	.039	.040	.042	.043	.044	.045	.046
37	.035	.036	.037	.038	.039	.041	.042	.043	.044	.045
38	.034	.035	.036	.037	.038	.039	.041	.042	.043	.044
39	.033	.034	.035	.036	.037	.038	.040	.041	.042	.043
40	.032	.033	.034	.035	.036	.037	.039	.040	.041	.042

No. of yarn	Picks per inch.									
	40	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**
10	.171	.176	.180	.184	.189	.193	.197	.201	.206	.210
11	.156	.160	.164	.168	.171	.175	.179	.183	.187	.191
12	.143	.146	.150	.154	.157	.161	.164	.168	.171	.175
13	.132	.135	.138	.142	.145	.148	.152	.155	.158	.162
14	.122	.126	.129	.132	.135	.138	.141	.144	.147	.150
15	.114	.117	.120	.123	.126	.129	.131	.134	.137	.140
16	.107	.110	.112	.115	.118	.121	.123	.126	.129	.131
17	.101	.103	.106	.108	.111	.113	.116	.118	.121	.124
18	.095	.098	.100	.102	.105	.107	.110	.112	.114	.117
19	.090	.092	.095	.097	.099	.102	.104	.106	.108	.110
20	.086	.088	.090	.092	.094	.096	.099	.101	.103	.105
21	.082	.084	.086	.088	.090	.092	.094	.096	.098	.100
22	.078	.080	.082	.084	.086	.088	.090	.092	.094	.095
23	.075	.076	.078	.080	.082	.084	.086	.088	.089	.091
24	.071	.073	.075	.077	.079	.080	.082	.084	.086	.087
25	.069	.070	.072	.074	.075	.077	.079	.081	.082	.084
26	.066	.068	.069	.071	.073	.074	.076	.077	.079	.081
27	.063	.065	.067	.068	.070	.071	.073	.075	.076	.078
28	.061	.063	.064	.066	.067	.069	.070	.072	.073	.075
29	.059	.061	.062	.064	.065	.067	.068	.069	.071	.072
30	.057	.059	.060	.061	.063	.064	.066	.067	.069	.070
31	.055	.057	.058	.059	.061	.062	.064	.065	.066	.068
32	.054	.055	.056	.058	.059	.060	.062	.063	.064	.066
33	.052	.053	.055	.056	.057	.058	.060	.061	.062	.064
34	.050	.052	.053	.054	.055	.057	.058	.059	.061	.062
35	.049	.050	.051	.053	.054	.055	.056	.058	.059	.060
36	.048	.049	.050	.051	.052	.054	.055	.056	.057	.058
37	.046	.047	.049	.050	.051	.052	.053	.054	.056	.057
38	.045	.046	.047	.048	.050	.051	.052	.053	.054	.055
39	.044	.045	.046	.047	.048	.049	.051	.052	.053	.054
40	.043	.044	.045	.046	.047	.048	.049	.050	.051	.052
41	.042	.043	.044	.045	.046	.047	.048	.049	.050	.051
42	.041	.042	.043	.044	.045	.046	.047	.048	.049	.050
43	.040	.041	.042	.043	.044	.045	.046	.047	.048	.049
44	.039	.040	.041	.042	.043	.044	.045	.046	.047	.048
45	.038	.039	.040	.041	.042	.043	.044	.045	.046	.047
	50	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**
10	.214	.219	.223	.227	.231	.236	.240	.244	.249	.253
11	.195	.199	.203	.206	.210	.214	.218	.222	.226	.230
12	.179	.182	.186	.189	.193	.196	.200	.204	.207	.211
13	.165	.168	.171	.175	.178	.181	.185	.188	.191	.195
14	.153	.156	.159	.162	.165	.168	.171	.174	.178	.181
15	.143	.146	.149	.151	.154	.157	.160	.163	.166	.169
16	.134	.137	.139	.142	.145	.147	.150	.153	.155	.158
17	.126	.129	.131	.134	.136	.139	.141	.144	.146	.149
18	.119	.121	.124	.126	.129	.131	.133	.136	.138	.140
19	.113	.115	.117	.120	.122	.124	.126	.129	.131	.133
20	.107	.109	.111	.114	.116	.118	.120	.122	.124	.126
21	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120
22	.097	.099	.101	.103	.105	.107	.109	.111	.113	.115
23	.093	.095	.097	.099	.101	.102	.104	.106	.108	.110
24	.089	.091	.093	.095	.096	.098	.100	.102	.104	.105
25	.086	.087	.089	.091	.093	.094	.096	.098	.099	.101
26	.082	.084	.086	.087	.089	.091	.092	.094	.096	.097
27	.079	.081	.083	.084	.086	.087	.089	.090	.092	.094
28	.077	.078	.080	.081	.083	.084	.086	.087	.089	.090
29	.074	.075	.077	.078	.080	.081	.083	.084	.086	.087
30	.071	.073	.074	.076	.077	.079	.080	.081	.083	.084
31	.069	.071	.072	.073	.075	.076	.077	.079	.080	.082
32	.067	.068	.070	.071	.072	.074	.075	.076	.078	.079
33	.065	.066	.068	.069	.070	.071	.073	.074	.075	.077
34	.063	.064	.066	.067	.068	.069	.071	.072	.073	.074
35	.061	.062	.064	.065	.066	.067	.069	.070	.071	.072
36	.060	.061	.062	.063	.064	.065	.067	.068	.069	.070
37	.058	.059	.060	.061	.063	.064	.065	.066	.067	.068
38	.056	.058	.059	.060	.061	.062	.063	.064	.065	.067
39	.055	.056	.057	.058	.059	.060	.062	.063	.064	.065
40	.054	.055	.056	.057	.058	.059	.060	.061	.062	.063
41	.052	.053	.054	.055	.056	.057	.059	.060	.061	.062
42	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060
43	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059
44	.049	.050	.051	.052	.053	.054	.055	.056	.056	.057
45	.048	.049	.050	.050	.051	.052	.053	.054	.055	.056

No. of yarn.	Picks per inch.										
	60	62	64	66	68	70	72	74	76	78	80
15	.171	.177	.183	.189	.194	.200	.206	.211	.217	.223	.229
16	.161	.166	.171	.177	.182	.187	.193	.197	.204	.209	.214
17	.151	.156	.161	.166	.171	.176	.182	.187	.192	.197	.202
18	.143	.148	.152	.157	.162	.167	.171	.176	.181	.186	.190
19	.135	.140	.144	.149	.153	.158	.162	.167	.171	.176	.180
20	.129	.133	.137	.141	.146	.150	.154	.159	.163	.167	.171
21	.122	.127	.131	.135	.139	.143	.147	.151	.155	.159	.163
22	.117	.121	.125	.129	.132	.136	.140	.144	.148	.152	.156
23	.112	.116	.119	.123	.127	.130	.134	.138	.142	.145	.149
24	.107	.111	.114	.118	.121	.125	.129	.132	.136	.139	.143
25	.103	.106	.110	.113	.117	.120	.123	.127	.130	.134	.137
26	.099	.102	.105	.109	.112	.115	.119	.122	.125	.129	.132
27	.095	.098	.102	.105	.108	.111	.114	.117	.121	.124	.127
28	.092	.095	.098	.101	.104	.107	.110	.113	.116	.119	.122
29	.089	.092	.095	.098	.100	.103	.106	.109	.112	.115	.118
30	.086	.089	.091	.094	.097	.100	.103	.106	.109	.111	.114
31	.083	.086	.088	.091	.094	.097	.100	.102	.105	.108	.111
32	.080	.083	.086	.088	.091	.094	.096	.099	.102	.104	.107
33	.078	.081	.083	.086	.088	.091	.094	.096	.099	.101	.104
34	.076	.078	.081	.083	.086	.088	.091	.093	.096	.098	.101
35	.073	.076	.078	.081	.083	.086	.088	.091	.093	.096	.098
36	.071	.074	.076	.079	.081	.083	.086	.088	.090	.093	.095
37	.069	.072	.074	.076	.079	.081	.083	.086	.088	.090	.093
38	.068	.070	.072	.074	.077	.079	.081	.083	.086	.088	.090
39	.066	.068	.070	.073	.075	.077	.079	.081	.084	.086	.088
40	.064	.066	.069	.071	.075	.075	.077	.079	.081	.084	.086
41	.063	.065	.067	.069	.071	.073	.075	.077	.079	.082	.084
42	.061	.063	.065	.067	.069	.071	.073	.076	.078	.080	.082
43	.060	.062	.064	.066	.068	.070	.072	.074	.076	.078	.080
44	.058	.060	.062	.064	.066	.068	.070	.072	.074	.076	.078
45	.057	.059	.061	.063	.065	.067	.069	.070	.072	.074	.076
46	.056	.058	.060	.061	.063	.065	.067	.069	.071	.073	.075
47	.055	.057	.058	.060	.062	.064	.066	.067	.069	.071	.073
48	.054	.055	.057	.059	.061	.062	.064	.066	.068	.070	.071
49	.052	.054	.056	.058	.059	.061	.063	.065	.066	.068	.070
50	.051	.053	.055	.057	.058	.060	.062	.063	.065	.067	.069
	80	**82**	**84**	**86**	**88**	**90**	**92**	**94**	**96**	**98**	**100**
20	.171	.176	.180	.184	.189	.193	.197	.201	.206	.210	.214
21	.163	.167	.171	.176	.180	.184	.188	.192	.196	.200	.204
22	.156	.160	.164	.168	.171	.175	.179	.183	.187	.191	.195
23	.149	.153	.157	.160	.164	.168	.171	.175	.179	.183	.186
24	.143	.146	.150	.154	.157	.161	.164	.168	.171	.175	.179
25	.137	.141	.144	.147	.151	.154	.158	.161	.165	.168	.171
26	.132	.135	.138	.142	.145	.148	.152	.155	.158	.162	.165
27	.127	.130	.133	.137	.140	.143	.146	.149	.152	.156	.159
28	.122	.126	.129	.132	.135	.138	.141	.144	.147	.150	.153
29	.118	.121	.124	.127	.130	.133	.136	.139	.142	.145	.148
30	.114	.117	.120	.123	.126	.129	.131	.134	.137	.140	.143
31	.111	.113	.116	.119	.122	.124	.127	.130	.133	.135	.138
32	.107	.110	.112	.115	.118	.121	.123	.126	.129	.131	.134
33	.104	.107	.109	.112	.114	.117	.119	.122	.125	.127	.130
34	.101	.103	.106	.108	.111	.113	.116	.118	.121	.124	.126
35	.098	.100	.103	.105	.108	.110	.113	.115	.118	.120	.122
36	.095	.098	.100	.102	.105	.107	.110	.112	.114	.117	.119
37	.093	.095	.097	.100	.102	.104	.107	.109	.111	.114	.116
38	.090	.092	.095	.097	.099	.102	.104	.106	.108	.110	.113
39	.088	.090	.092	.095	.097	.099	.101	.103	.105	.107	.110
40	.086	.088	.090	.092	.094	.096	.099	.101	.103	.105	.107
41	.084	.086	.088	.090	.092	.094	.096	.098	.100	.102	.105
42	.082	.084	.086	.088	.090	.092	.094	.096	.098	.100	.102
43	.080	.082	.084	.086	.088	.090	.092	.094	.096	.098	.100
44	.078	.080	.082	.084	.086	.088	.090	.092	.094	.095	.097
45	.076	.078	.080	.082	.084	.086	.088	.090	.091	.093	.095
46	.075	.076	.078	.080	.082	.084	.086	.088	.089	.091	.093
47	.073	.075	.077	.078	.080	.082	.084	.086	.088	.089	.091
48	.071	.073	.075	.077	.079	.080	.082	.084	.086	.087	.089
49	.070	.072	.073	.075	.077	.079	.080	.082	.084	.086	.087
50	.069	.070	.072	.074	.075	.077	.079	.081	.082	.084	.086
51	.067	.069	.071	.072	.074	.076	.077	.079	.081	.082	.084
52	.066	.068	.069	.071	.073	.074	.076	.077	.079	.081	.082
53	.065	.066	.068	.070	.071	.073	.074	.076	.078	.079	.081
54	.063	.065	.067	.068	.070	.071	.073	.075	.076	.078	.079
55	.062	.064	.065	.067	.069	.070	.072	.073	.075	.076	.078

No. of yarn.	Picks per inch.										
	100	**102**	**104**	**106**	**108**	**110**	**112**	**114**	**116**	**118**	**120**
30	.143	.146	.149	.151	.154	.157	.160	.163	.166	.169	.171
31	.138	.141	.144	.147	.149	.152	.155	.158	.160	.163	.166
32	.134	.137	.139	.142	.145	.147	.150	.153	.155	.158	.161
33	.130	.133	.135	.138	.140	.143	.145	.148	.151	.153	.156
34	.126	.129	.131	.134	.136	.139	.141	.144	.146	.149	.151
35	.122	.125	.127	.130	.132	.135	.137	.140	.142	.144	.147
36	.119	.121	.124	.126	.129	.131	.133	.136	.138	.140	.143
37	.116	.118	.120	.123	.125	.127	.130	.132	.134	.137	.139
38	.113	.115	.117	.120	.122	.124	.126	.129	.131	.133	.135
39	.110	.112	.114	.116	.119	.121	.123	.125	.127	.130	.132
40	.107	.109	.111	.114	.116	.118	.120	.122	.124	.126	.129
42	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120	.122
44	.097	.099	.101	.103	.105	.107	.109	.111	.113	.115	.117
46	.093	.095	.097	.099	.101	.102	.104	.106	.108	.110	.112
48	.089	.091	.093	.095	.096	.098	.100	.102	.104	.105	.107
50	.086	.087	.089	.091	.093	.094	.096	.098	.099	.101	.103
52	.082	.084	.086	.087	.089	.091	.092	.094	.096	.097	.099
54	.079	.081	.083	.084	.086	.087	.089	.090	.092	.094	.095
56	.077	.078	.080	.081	.083	.084	.086	.087	.089	.090	.092
58	.074	.075	.077	.078	.080	.081	.083	.084	.086	.087	.089
60	.071	.073	.074	.076	.077	.079	.080	.081	.083	.084	.086
62	.069	.071	.072	.073	.075	.076	.077	.079	.080	.082	.083
64	.067	.068	.070	.071	.072	.074	.075	.076	.078	.079	.080
66	.065	.066	.068	.069	.070	.071	.073	.074	.075	.077	.078
68	.063	.064	.066	.067	.068	.069	.071	.072	.073	.074	.076
70	.061	.062	.064	.065	.066	.067	.069	.070	.071	.072	.073
	120	**122**	**124**	**126**	**128**	**130**	**132**	**134**	**136**	**138**	**140**
40	.129	.131	.133	.135	.137	.139	.141	.144	.146	.148	.150
42	.122	.124	.127	.129	.131	.133	.135	.137	.139	.141	.143
44	.117	.119	.121	.123	.125	.127	.129	.131	.132	.134	.136
46	.112	.114	.116	.117	.119	.121	.123	.125	.127	.129	.130
48	.107	.109	.111	.112	.114	.116	.118	.120	.121	.123	.125
50	.103	.105	.106	.108	.110	.111	.113	.115	.117	.118	.120
52	.099	.101	.102	.104	.105	.107	.109	.110	.112	.114	.115
54	.095	.097	.098	.100	.102	.103	.105	.106	.108	.109	.111
56	.092	.093	.095	.096	.098	.099	.101	.103	.104	.106	.107
58	.089	.090	.092	.093	.095	.096	.098	.099	.100	.102	.103
60	.086	.087	.089	.090	.091	.093	.094	.096	.097	.099	.100
62	.083	.084	.086	.087	.088	.090	.091	.093	.094	.095	.097
64	.080	.082	.083	.084	.086	.087	.088	.090	.091	.092	.094
66	.078	.079	.081	.082	.083	.084	.086	.087	.088	.090	.091
68	.076	.077	.078	.079	.081	.082	.083	.084	.086	.087	.088
70	.073	.075	.076	.077	.078	.080	.081	.082	.083	.084	.086
72	.071	.073	.074	.075	.076	.077	.079	.080	.081	.082	.083
74	.069	.071	.072	.073	.074	.075	.076	.078	.079	.080	.081
76	.068	.069	.070	.071	.072	.073	.074	.076	.077	.078	.079
78	.066	.067	.068	.069	.070	.071	.073	.074	.075	.076	.077
80	.064	.065	.066	.067	.069	.070	.071	.072	.073	.074	.075
	140	**142**	**144**	**146**	**148**	**150**	**152**	**154**	**156**	**158**	**160**
50	.120	.122	.123	.125	.127	.129	.130	.132	.134	.135	.137
52	.115	.117	.119	.120	.122	.124	.125	.127	.129	.130	.132
54	.111	.113	.114	.116	.117	.119	.121	.122	.124	.125	.127
56	.107	.109	.110	.112	.113	.115	.116	.118	.119	.121	.122
58	.103	.105	.106	.108	.109	.111	.112	.114	.115	.117	.118
60	.100	.101	.103	.104	.106	.107	.109	.110	.111	.113	.114
65	.092	.094	.095	.096	.098	.099	.100	.102	.103	.104	.105
70	.086	.087	.088	.089	.091	.092	.093	.094	.096	.097	.098
75	.080	.081	.082	.083	.085	.086	.087	.088	.089	.090	.092
80	.075	.076	.077	.078	.079	.080	.081	.083	.084	.085	.086
85	.071	.072	073	.074	.075	.076	.077	.078	.079	.080	.081
	160	**162**	**164**	**166**	**168**	**170**	**172**	**174**	**176**	**178**	**180**
60	.114	.116	.117	.119	.120	.121	.123	.124	.126	.127	.129
65	.105	.106	.108	.109	.111	.112	.113	.115	.116	.117	.119
70	.098	.099	.100	.102	.103	.104	.105	.107	.108	.109	.110
75	.092	.093	.094	.095	.096	.097	.098	.099	.101	.102	.103
80	.086	.087	.088	.089	.090	.091	.092	.093	.094	.095	.096
85	.081	.082	.083	.084	.085	.086	.087	.088	.089	.090	.091
90	.076	.077	.078	.079	.080	.081	.082	.083	.084	.085	.086
95	.072	.073	.074	.075	.076	.076	.077	.078	.079	.080	.081
100	.069	.070	.070	.071	.072	.073	074	.075	.075	.076	.077

Picks per inch.	Picks per minute.										
	100	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**
20	83.3	87.5	91.7	95.8	100.0	104.2	108.3	112.5	116.7	120.8	125.0
22	75.8	79.5	83.3	87.1	90.9	94.7	98.5	102.3	106.1	109.8	113.6
24	69.4	72.9	76.4	79.9	83.3	86.8	90.3	93.7	97.2	100.7	104.2
26	64.1	67.3	70.5	73.7	76.9	80.1	83.3	86.5	89.7	92.9	96.2
28	59.5	62.5	65.5	68.5	71.4	74.4	77.4	80.4	83.3	86.3	89.3
30	55.6	58.3	61.1	63.9	66.7	69.4	72.2	75.0	77.8	80.6	83.3
32	52.1	54.7	57.3	59.9	62.5	65.1	67.7	70.3	72.9	75.5	78.1
34	49.0	51.5	53.9	56.4	58.8	61.3	63.7	66.2	68.6	71.1	73.5
36	46.3	48.6	50.9	53.2	55.6	57.9	60.2	62.5	64.8	67.1	69.4
38	43.9	46.1	48.2	50.4	52.6	54.8	57.0	59.2	61.4	63.6	65.8
40	41.7	43.7	45.8	47.9	50.0	52.1	54.2	56.3	58.3	60.4	62.5
42	39.7	41.7	43.7	45.6	47.6	49.6	51.6	53.6	55.6	57.5	59.5
44	37.9	39.8	41.7	43.6	45.5	47.3	49.2	51.1	53.0	54.9	56.8
46	36.2	38.0	39.9	41.7	43.5	45.3	47.1	48.9	50.7	52.5	54.3
48	34.7	36.5	38.2	39.9	41.7	43.4	45.1	46.9	48.6	50.3	52.1
50	33.3	35.0	36.7	38.3	40.0	41.7	43.3	45.0	46.7	48.3	50.0
52	32.1	33.7	35.3	36.9	38.5	40.1	41.7	43.3	44.9	46.5	48.1
54	30.9	32.4	34.0	35.5	37.0	38.6	40.1	41.7	43.2	44.8	46.3
56	29.8	31.3	32.7	34.2	35.7	37.2	38.7	40.2	41.7	43.2	44.6
58	28.7	30.2	31.6	33.0	34.5	35.9	37.4	38.8	40.2	41.7	43.1
60	27.8	29.2	30.6	31.9	33.3	34.7	36.1	37.5	38.9	40.3	41.7
62	26.9	28.2	29.6	30.9	32.3	33.6	34.9	36.3	37.6	39.0	40.3
64	26.0	27.3	28.6	29.9	31.3	32.6	33.9	35.2	36.5	37.8	39.1
66	25.3	26.5	27.8	29.0	30.3	31.6	32.8	34.1	35.4	36.6	37.9
68	24.5	25.7	27.0	28.2	29.4	30.6	31.9	33.1	34.3	35.5	36.8
70	23.8	25.0	26.2	27.4	28.6	29.8	31.0	32.1	33.3	34.5	35.7
72	23.1	24.3	25.5	26.6	27.8	28.9	30.1	31.3	32.4	33.6	34.7
74	22.5	23.6	24.8	25.9	27.0	28.2	29.3	30.4	31.5	32.7	33.8
76	21.9	23.0	24.1	25.2	26.3	27.4	28.5	29.6	30.7	31.8	32.9
78	21.4	22.4	23.5	24.6	25.6	26.7	27.8	28.8	29.9	31.0	32.1
80	20.8	21.9	22.9	24.0	25.0	26.0	27.1	28.1	29.2	30.2	31.3
82	20.3	21.3	22.4	23.4	24.4	25.4	26.4	27.4	28.5	29.5	30.5
84	19.8	20.8	21.8	22.8	23.8	24.8	25.8	26.8	27.8	28.8	29.8
86	19.4	20.3	21.3	22.3	23.3	24.2	25.2	26.2	27.1	28.1	29.1
88	18.9	19.9	20.8	21.8	22.7	23.7	24.6	25.6	26.5	27.5	28.4
90	18.5	19.4	20.4	21.3	22.2	23.1	24.1	25.0	25.9	26.9	27.8
92	18.1	19.0	19.9	20.8	21.7	22.6	23.6	24.5	25.4	26.3	27.2
94	17.7	18.6	19.5	20.4	21.3	22.2	23.0	23.9	24.8	25.7	26.6
96	17.4	18.2	19.1	20.0	20.8	21.7	22.6	23.4	24.3	25.2	26.0
98	17.0	17.9	18.7	19.6	20.4	21.3	22.1	23.0	23.8	24.7	25.5
100	16.7	17.5	18.3	19.2	20.0	20.8	21.7	22.5	23.3	24.2	25.0
102	16.3	17.2	18.0	18.8	19.6	20.4	21.2	22.1	22.9	23.7	24.5
104	16.0	16.8	17.6	18.4	19.2	20.0	20.8	21.6	22.4	23.2	24.0
106	15.7	16.5	17.3	18.1	18.9	19.7	20.4	21.2	22.0	22.8	23.6
108	15.4	16.2	17.0	17.7	18.5	19.3	20.1	20.8	21.6	22.4	23.1
110	15.2	15.9	16.7	17.4	18.2	18.9	19.7	20.5	21.2	22.0	22.7
112	14.9	15.6	16.4	17.1	17.9	18.6	19.3	20.1	20.8	21.6	22.3
114	14.6	15.4	16.1	16.8	17.5	18.3	19.0	19.7	20.5	21.2	21.9
116	14.4	15.1	15.8	16.5	17.2	18.0	18.7	19.4	20.1	20.8	21.6
118	14.1	14.8	15.5	16.2	16.9	17.7	18.4	19.1	19.8	20.5	21.2
120	13.9	14.6	15.3	16.0	16.7	17.4	18.1	18.7	19.4	20.1	20.8
122	13.7	14.3	15.0	15.7	16.4	17.1	17.8	18.4	19.1	19.8	20.4
124	13.4	14.1	14.8	15.5	16.1	16.8	17.5	18.1	18.8	19.5	20.1
126	13.2	13.9	14.6	15.2	15.9	16.5	17.2	17.9	18.5	19.2	19.8
128	13.0	13.7	14.3	15.0	15.6	16.3	16.9	17.6	18.2	18.9	19.5
130	12.8	13.5	14.1	14.7	15.4	16.0	16.7	17.3	17.9	18.6	19.2
134	12.4	13.1	13.7	14.3	14.9	15.5	16.2	16.8	17.4	18.0	18.7
136	12.3	12.9	13.5	14.1	14.7	15.3	15.9	16.5	17.2	17.8	18.4
140	11.9	12.5	13.1	13.7	14.3	14.9	15.5	16.1	16.7	17.3	17.9
144	11.6	12.2	12.7	13.3	13.9	14.5	15.0	15.6	16.2	16.8	17.4
146	11.4	12.0	12.6	13.1	13 7	14.3	14.8	15.4	16.0	16.6	17.1
150	11.1	11.7	12.2	12.8	13.3	13.9	14.4	15.0	15.6	16.1	16.7
154	10.8	11.4	11.9	12.4	13.0	13.5	14.1	14.6	15.2	15.7	16.2
156	10.7	11.2	11.8	12.3	12.8	13.4	13.9	14.4	15.0	15.5	16.0
160	10.4	10.9	11.5	12.0	12.5	13.0	13.5	14.1	14.6	15.1	15.6
164	10.2	10.7	11.2	11.7	12.2	12.7	13.2	13.7	14.2	14.7	15.2
166	10.0	10.5	11.0	11.5	12.0	12.6	13.1	13.5	14.1	14.6	15.1
170	9.8	10.3	10.8	11.3	11.8	12.3	12.7	13.2	13.7	14.2	14.7
174	9.6	10.1	10.5	11.0	11.5	12.0	12.5	12.9	13.4	13.9	14.4
176	9.5	9.9	10.4	10.9	11.4	11.8	12.3	12.8	13.3	13.7	14.2
180	9.3	9.7	10.2	10.6	11.1	11.6	12.0	12.5	13.0	13.4	13.9

Picks per inch.	Picks per minute.										
	155	**160**	**165**	**170**	**175**	**180**	**185**	**190**	**195**	**200**	**205**
20	129.2	133.3	137.5	141.7	145.8	150.0	154.2	158.3	162.5	166.7	170.8
22	117.4	121.2	125.0	128.8	132.6	136.4	140.2	143.9	147.7	151.5	155.3
24	107.6	111.1	114.6	118.1	121.5	125.0	128.5	131.9	135.4	138.9	142.4
26	99.4	102.6	105.8	109.0	112.2	115.4	118.6	121.8	125.0	128.2	131.4
28	92.3	95.2	98.2	101.2	104.2	107.1	110.1	113.1	116.1	119.0	122.0
30	86.1	88.9	91.7	94.4	97.2	100.0	102.8	105.5	108.3	111.1	113.9
32	80.7	83.3	85.9	88.5	91.1	93.7	96.4	99.0	101.6	104.2	106.8
34	76.0	78.4	80.9	83.3	85.8	88.2	90.7	93.1	95.6	98.0	100.5
36	71.8	74.1	76.4	78.7	81.0	83.3	85.6	88.0	90.3	92.6	94.9
38	68.0	70.2	72.4	74.6	76.8	78.9	81.1	83.3	85.5	87.7	89.9
40	64.6	66.7	68.7	70.8	72.9	75.0	77.1	79.2	81.3	83.3	85.4
42	61.5	63.5	65.5	67.5	69.4	71.4	73.4	75.4	77.4	79.4	81.3
44	58.7	60.6	62.5	64.4	66.3	68.2	70.1	72.0	73.9	75.8	77.7
46	56.2	58.0	59.8	61.6	63.4	65.2	67.0	68.8	70.7	72.5	74.3
48	53.8	55.6	57.3	59.0	60.8	62.5	64.2	66.0	67.7	69.4	71.2
50	51.7	53.3	55.0	56.7	58.3	60.0	61.7	63.3	65.0	66.7	68.3
52	49.7	51.3	52.9	54.5	56.1	57.7	59.3	60.9	62.5	64.1	65.7
54	47.8	49.4	50.9	52.5	54.0	55.6	57.1	58.6	60.2	61.7	63.3
56	46.1	47.6	49.1	50.6	52.1	53.6	55.1	56.5	58.0	59.5	61.0
58	44.5	46.0	47.4	48.8	50.3	51.7	53.2	54.6	56.0	57.5	58.9
60	43.1	44.4	45.8	47.2	48.6	50.0	51.4	52.8	54.2	55.6	56.9
62	41.7	43.0	44.4	45.7	47.0	48.4	49.7	51.1	52.4	53.8	55.1
64	40.4	41.7	43.0	44.3	45.6	46.9	48.2	49.5	50.8	52.1	53.4
66	39.1	40.4	41.7	42.9	44.2	45.5	46.7	48.0	49.2	50.5	51.8
68	38.0	39.2	40.4	41.7	42.9	44.1	45.3	46.6	47.8	49.0	50.2
70	36.9	38.1	39.3	40.5	41.7	42.9	44.0	45.2	46.4	47.6	48.8
72	35.9	37.0	38.2	39.4	40.5	41.7	42.8	44.0	45.1	46.3	47.5
74	34.9	36.0	37.2	38.3	39.4	40.5	41.7	42.8	43.9	45.0	46.2
76	34.0	35.1	36.2	37.3	38.4	39.5	40.6	41.7	42.8	43.9	45.0
78	33.1	34.2	35.3	36.3	37.4	38.5	39.5	40.6	41.7	42.7	43.8
80	32.3	33.3	34.4	35.4	36.5	37.5	38.5	39.6	40.6	41.7	42.7
82	31.5	32.5	33.5	34.6	35.6	36.6	37.6	38.6	39.6	40.7	41.7
84	30.8	31.7	32.7	33.7	34.7	35.7	36.6	37.7	38.7	39.7	40.7
86	30.0	31.0	32.0	32.9	33.9	34.9	35.8	36.8	37.8	38.8	39.7
88	29.4	30.3	31.3	32.2	33.1	34.1	35.0	36.0	36.9	37.9	38.8
90	28.7	29.6	30.6	31.5	32.4	33.3	34.3	35.2	36.1	37.0	38.0
92	28.1	29.0	29.9	30.8	31.7	32.6	33.5	34.4	35.3	36.2	37.1
94	27.5	28.4	29.3	30.1	31.0	31.9	32.8	33.7	34.6	35.5	36.3
96	26.9	27.8	28.6	29.5	30.4	31.3	32.1	33.0	33.9	34.7	35.6
98	26.4	27.2	28.1	28.9	29.8	30.6	31.5	32.3	33.2	34.0	34.9
100	25.8	26.7	27.5	28.3	29.2	30.0	30.8	31.7	32.5	33.3	34.4
102	25.3	26.1	27.0	27.8	28.6	29.4	30.2	31.0	31.9	32.7	33.5
104	24.8	25.6	26.4	27.2	28.0	28.8	29.6	30.4	31.3	32.1	32.9
106	24.4	25.2	25.9	26.7	27.5	28.3	29.1	29.9	30.7	31.4	32.2
108	23.9	24.7	25.5	26.2	27.0	27.8	28.5	29.3	30.1	30.9	31.6
110	23.5	24.2	25.0	25.8	26.5	27.3	28.0	28.8	29.5	30.3	31.1
112	23.1	23.8	24.6	25.3	26.0	26.8	27.5	28.3	29.0	29.8	30.5
114	22.7	23.4	24.1	24.9	25.6	26.3	27.0	27.8	28.5	29.2	30.0
116	22.3	23.0	23.7	24.4	25.1	25.9	26.6	27.3	28.0	28.7	29.5
118	21.9	22.6	23.3	24.0	24.7	25.4	26.1	26.8	27.5	28.2	29.0
120	21.5	22.2	22.9	23.6	24.3	25.0	25.7	26.4	27.1	27.8	28.5
122	21.2	21.9	22.5	23.2	23.9	24.6	25.3	26.0	26.6	27.3	28.0
124	20.8	21.5	22.2	22.8	23.5	24.2	24.9	25.5	26.2	26.9	27.6
126	20.5	21.2	21.8	22.5	23.1	23.8	24.5	25.1	25.8	26.5	27.1
128	20.2	20.8	21.5	22.1	22.8	23.4	24.1	24.7	25.4	26.0	26.7
130	19.9	20.5	21.2	21.8	22.4	23.1	23.7	24.4	25.0	25.6	26.3
134	19.3	19.9	20.5	21.1	21.8	22.4	23.0	23.6	24.3	24.9	25.5
136	19.0	19.6	20.2	20.8	21.4	22.1	22.7	23.3	23.9	24.5	25.1
140	18.5	19.0	19.6	20.2	20.8	21.4	22.0	22.6	23.2	23.8	24.4
144	17.9	18.5	19.1	19.7	20.3	20.8	21.4	22.0	22.6	23.1	23.7
146	17.7	18.3	18.8	19.4	20.0	20.5	21.1	21.7	22.3	22.8	23.4
150	17.2	17.8	18.3	18.9	19.4	20.0	20.6	21.1	21.7	22.2	22.8
154	16.8	17.3	17.9	18.4	18.9	19.5	20.0	20.6	21.1	21.6	22.2
156	16.6	17.1	17.6	18.2	18.7	19.2	19.8	20.3	20.8	21.4	21.9
160	16.1	16.7	17.2	17.7	18.2	18.7	19.3	19.8	20.3	20.8	21.4
164	15.8	16.3	16.8	17.3	17.8	18.3	18.8	19.3	19.8	20.3	20.8
166	15.6	16.1	16.6	17.1	17.6	18.1	18.6	19.1	19.6	20.1	20.6
170	15.2	15.7	16.2	16.7	17.2	17.6	18.1	18.6	19.1	19.6	20.1
174	14.8	15.4	15.8	16.3	16.8	17.2	17.7	18.2	18.7	19.2	19.6
176	14.7	15.2	15.6	16.1	16.6	17.0	17.5	18.0	18.5	18.9	19.4
180	14.4	14.8	15.3	15.7	16.2	16.7	17.1	17.6	18.1	18.5	19.0

REED TABLE.

Ends per Inch.	Ends in Cloth.	PLAIN CLOTH.			FOR DRILLS.		
		Dents per Inch.	Two Ends per Reed Dent. Total Dents.	Width of Reed or Spread.	Dents in Inch.	Three Ends per Reed Dent. Total Dents.	Width of Reed or Inches Spread.
32	1176	14.67	576	39.25	10.16	392	38.58
34	1248	15.59	612	39.25	10.79	416	38.55
36	1320	16.51	648	39.25	11.42	440	38.52
38	1392	17.42	684	39.25	12.06	464	38.47
40	1464	18.34	720	39.25	12.69	488	38.47
42	1536	19.26	756	39.25	13.33	512	38.40
44	1608	20.17	792	39.25	13.96	536	38.37
46	1680	21.09	828	39.25	14.60	560	38.35
48	1752	22.01	864	39.25	15.23	584	38.34
50	1824	22.93	900	39.25	15.87	608	38.33
52	1896	23.85	936	39.25	16.50	632	38.32
54	1968	24.77	972	39.25	17.14	656	38.27
56	2040	25.68	1008	39.25	17.77	680	38.26
58	2112	26.60	1044	39.25	18.41	704	38.24
60	2184	27.51	1080	39.25	19.04	728	38.23
62	2256	28.43	1116	39.25	19.68	752	38.20
64	2328	29.35	1152	39.25	20.32	776	38.19
66	2400	30.22	1188	39.25	20.95	800	38.18
68	2472	31.18	1224	39.25	21.58	824	38.18
70	2544	32.10	1260	39.25	22.22	848	38.17
72	2616	33.02	1296	39.25	22.85	872	38.16
74	2688	33.94	1332	39.25	23.49	896	38.14
76	2760	34.85	1368	39.25	24.12	920	38.14
78	2832	35.77	1404	39.25	24.76	944	38.13
80	2904	36.69	1440	39.25	25.39	968	38.12
82	2976	37.60	1476	39.25	26.03	992	38.12
84	3048	38.52	1512	39.25	26.66	1016	38.12
86	3120	39.44	1548	39.25	27.30	1040	38.09
88	3192	40.35	1584	39.25	27.94	1064	38.08
90	3264	41.27	1620	39.25	28.58	1088	38.07
92	3336	42.19	1656	39.25	29.22	1112	38.06
94	3408	43.11	1692	39.25	29.86	1136	38.05
96	3480	44.02	1728	39.25	30.50	1160	38.03
98	3552	44.92	1764	39.25	31.14	1184	38.02
100	3624	45.85	1800	39.25	31.78	1208	38.00

This table is made out for cloth 36″ wide—all other widths of cloth, proportion must be made. Twenty-four ends are allowed in every case for selvage.

For two harness plain, eyes on each harness = Total dents.

For three harness drill, eyes on each harness = Total dents.

Table to Facilitate the Conversion of Yards to the Pound to Their Decimal Equivalent.

YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.
1.00	1.0000	2.00	.5000	3.00	.3333	4.00	.2500	5.00	.2000	6.00	.1667	7.00	.1429	8.00	.1250
.05	.9524	.05	.4878	.05	.3279	.05	.2469	.05	.1980	.05	.1653	.05	.1418	.05	.1242
.10	.9091	.10	.4762	.10	.3226	.10	.2439	.10	.1961	.10	.1639	.10	.1408	.10	.1235
.15	.8696	.15	.4651	.15	.3175	.15	.2410	.15	.1942	.15	.1626	.15	.1399	.15	.1227
.20	.8333	.20	.4545	.20	.3125	.20	.2381	.20	.1923	.20	.1613	.20	.1389	.20	.1220
.25	.8000	.25	.4444	.25	.3077	.25	.2353	.25	.1905	.25	.1600	.25	.1379	.25	.1212
.30	.7692	.30	.4348	.30	.3030	.30	.2326	.30	.1887	.30	.1587	.30	.1370	.30	.1205
.35	.7407	.35	.4255	.35	.2985	.35	.2299	.35	.1869	.35	.1575	.35	.1361	.35	.1198
.40	.7143	.40	.4167	.40	.2941	.40	.2273	.40	.1852	.40	.1562	.40	.1351	.40	.1190
.45	.6897	.45	.4082	.45	.2899	.45	.2247	.45	.1835	.45	.1550	.45	.1342	.45	.1183
.50	.6667	.50	.4000	.50	.2857	.50	.2222	.50	.1818	.50	.1538	.50	.1333	.50	.1176
.55	.6452	.55	.3922	.55	.2817	.55	.2198	.55	.1802	.55	.1527	.55	.1325	.55	.1170
.60	.6250	.60	.3846	.60	.2778	.60	.2174	.60	.1786	.60	.1515	.60	.1316	.60	.1163
.65	.6061	.65	.3774	.65	.2740	.65	.2151	.65	.1770	.65	.1504	.65	.1307	.65	.1156
.70	.5882	.70	.3704	.70	.2703	.70	.2128	.70	.1754	.70	.1493	.70	.1299	.70	.1149
.75	.5714	.75	.3636	.75	.2667	.75	.2105	.75	.1739	.75	.1481	.75	.1290	.75	.1143
.80	.5556	.80	.3571	.80	.2632	.80	.2083	.80	.1724	.80	.1471	.80	.1282	.80	.1136
.85	.5405	.85	.3509	.85	.2597	.85	.2062	.85	.1709	.85	.1460	.85	.1274	.85	.1130
.90	.5263	.90	.3448	.90	.2564	.90	.2041	.90	.1695	.90	.1449	.90	.1266	.90	.1124
.95	.5128	.95	.3390	.95	.2532	.95	.2020	.95	.1681	.95	.1439	.95	.1258	.95	.1117

CLOTH CONSTRUCTION TABLES.

To enable any person having four of the elements of a piece of cloth given, to find the fifth, or to construct a piece of cloth of any required reed, pick and weight.

How to use these tables:—These tables are calculated for cloth 36 in. wide, any other width must be converted to 36 in. by making proportion.

For example: If 40 in. cloth weighs 4 yards to one pound what will 36 in. cloth weigh?

$$\frac{40 \text{ ins.} \times 4 \text{ yds.}}{36 \text{ in.}} = 4.44+ \text{yds. to one pound.}$$

The "decimal equivalent" is the equivalent weight of one yard of cloth expressed in decimals of a pound. For example: If a cloth weighs 4 yards to the pound, one yard will weigh

$$\frac{1 \text{ lb.}}{4 \text{ yds.}} = .25 \text{ of a lb.} = \text{"decimal equivalent."}$$

In these tables the "Decimal equivalent" is divided by two, as warp and filling form each one-half of the cloth when the cloth has the same number of ends to the inch in the warp and filling, and where the same numbers of yarn are used in the warp and filling. For example: In a cloth 36 wide, 48 reed, 48 pick, 20s warp and 20s filling, the weight of warp and filling used is equal. In a cloth where any of these elements differ the weight of warp and filling are in proportion to each other as the number of threads to the inch and the numbers of yarn in the warp and filling.

In all calculations in which these tables are used, the weight of one yard of cloth 36 inches wide in pounds (decimal equivalent) must always be used.

The elements of a piece of cloth are in number five, viz:—

1. Reed or warp threads to the inch.
2. Pick or filling threads to the inch.
3. Warp yarns.
4. Filling yarn.
5. Weight of the cloth expressed in yards to the pound, ounces to the yard or decimal parts of a pound to the yard, which we have called the "decimal equivalent."

If we have any four of these elements given we can find the fifth.

FIRST.

Having given the reed, pick, warp and filling to find the weight.

Find the weight of the warp yarn in the given reed as per table.

Find the weight of the filling yarn in the given pick as per table.

Add these together. The sum is the weight of one yard of cloth expressed in decimals of a pound or its "decimal equivalent." If it is required to convert this weight into yards to the pound consult the table on page 103. If the weight of one yard is required in ounces, multiply the sum by 16 (the number of ounces in one pound.)

Example. Reed 48, pick 52, warp 18.50s, filling 20s.

Page 117. Op. 18.50 yarn under 48 reed is .1250 decimal equivalent.
" 117. " 20.03 " " " 52 " " .1250 " "

These numbers added equal wt. of 1 yd. .2500 of a lb.

Page 103 opposite .2500 we find 4 yards to the lb., which is the weight of the cloth, or $\frac{1 \text{ lb.}}{.2500} = 4$ yards to the pound or one yard weighs 4 ounces.

SECOND.

Having given the reed, pick, warp and weight, to find the filling number—

Find the weight in decimals of a pound, of one yard of cloth (table page 103) subtract from this the weight of the warp yarn in the given reed. Opposite the subtrahend, under the given pick, is the number of yarn required for the filling.

Example—Reed 48, pick 52, warp 18.50, weight 4 yards to the lb.

On page 103 opposite 4 yards is	.2500
On page 117 opposite 18.50 yarn under 48 reed is	.1250
	.1250

On page 117 opposite .1250, under 52 reed is 20s yarn, filling number required.

THIRD.

Having given the reed, pick, filling number and weight to find the warp number required.

Find the weight in decimals of a pound of one yard of cloth, subtract from this the weight of the filling yarn on the given pick. Opposite the subtrahend under the given reed, is the warp number required.

Example—Reed 48, pick 52, filling 20, weight 4 yards.

Page 103 opposite 4 yards is	.2500
Page 117 opposite 20 yarn under 52 reed is	.1250
	.1250

Page 117 opposite .1250 under 48 reed is 18.50. Warp number required.

FOURTH.

Having given the reed, filling, warp and weight, to find the pick.

Find the weight in decimals of a pound of one yard of cloth, from this subtract the weight of the warp yarn in the given reed. Opposite the subtrahend find the filling number. At the head of this column is the required number of picks per inch.

Example—Reed 48, filling 20, warp 18.50, weight 4 yards to the pound.

Page 103 opposite 4 yards is	.2500
Page 117 opposite 18.50 warp under 48 reed is	.1250
	.1250

Page 117. Find opposite .1250 number 20 filling and at the head of the column is 52 reed, the required pick.

FIFTH.

Having given the pick, filling, warp and weight to find the reed.

Find the weight in decimals of a pound of one yard of cloth, from this subtract the weight of the filling in the given pick. Opposite the subtrahend find the warp number. At the head of this column is the required reed.

Example—Pick 52, filling 18.50, warp 20s, weight 4 yards to the pound.

Page 103. Opposite 4 yards is	.2500
Page 117. Opposite 20 yarn under 52 reed is	.1250
	.1250

Page 117. Opposite .1250, find 18.50 warp number and at the head of the column is 48, the required reed.

SIXTH.

To find the average yarns in a piece of cloth of which the reed, pick and weight are given.

Add together the reed and picks, divide by two, to find the average number of threads to the inch. Opposite the weight of the cloth in yards to the pound under the average number of threads to the inch is the required yarn number.

Example—Cloth 60 reed, 56 picks, 5 yards to the pound.

60+56=116÷2=58 average reed.

Page 121. Opposite 5 yards to the pound under 58 reed is 27.92, the required yarn number.

Note. Rules 2 and 3 are alike, substituting warp for filling and vice versa.

Rules 4 and 5 are alike, substituting reed for pick and vice versa.

Many other problems will suggest themselves which can be solved easily by these tables.

Reed.	30	32	34	36	38
Yards per lb.	Decimal Equivalent	Numbers.			
1.00	.5000	3.08	3.27	3.46	3.65
.05	.4762	.23	.43	.64	.84
.10	.4545	.38	.60	.81	4.02
.15	.4348	.54	.76	.98	.20
.20	.4167	.69	.92	4.16	.39
.25	.4000	.85	4.09	.33	.57
.30	.3846	4.00	.25	.50	.75
.35	.3704	.16	.42	.68	.94
.40	.3571	.31	.58	.85	5.12
.45	.3448	.46	.74	5.02	.30
.50	.3333	.62	.91	.20	.48
.55	.3226	.77	5.07	.37	.67
.60	.3125	.93	.23	.54	.85
.65	.3030	5.08	.40	.72	6.03
.70	.2941	.23	.56	.89	.22
.75	.2857	.39	.72	6.06	.40
.80	.2778	.54	.89	.24	.58
.85	.2703	.70	6.05	.41	.76
.90	.2632	.85	.22	.58	.95
.95	.2564	6.00	.38	.76	7.13

Reed.	40	42	44	46	48
Yards per lb.	Decimal Equivalent	Numbers.			
1.00	.5000	3.85	4.04	4.23	4.42	4.62
.05	.4762	4.04	.24	.44	.65	.85
.10	.4545	.23	.44	.66	.87	5.08
.15	.4348	.42	.65	.87	5.09	.31
.20	.4167	.62	.85	5.08	.31	.54
.25	.4000	.81	5.05	.29	.53	.77
.30	.3846	5.00	.25	.50	.75	6.00
.35	.3704	.20	.46	.71	.98	.24
.40	.3571	.39	.66	.93	6.20	.47
.45	.3448	.58	.86	6.14	.42	.70
.50	.3333	.77	6.06	.35	.64	.93
.55	.3226	.97	.26	.56	.86	7.16
.60	.3125	6.16	.47	.77	7.08	.39
.65	.3030	.35	.67	.99	.30	.62
.70	.2941	.54	.87	7.20	.53	.85
.75	.2857	.74	7.07	.41	.75	8.08
.80	.2778	.93	.28	.62	.97	.32
.85	.2703	7.12	7.48	.83	8.19	.55
.90	.2632	.31	.68	8.04	.41	.78
.95	.2564	.51	.88	.26	.63	9.01

Yards per lb.	Reed. Decimal Equivalent	50	52	54	56	58
		Numbers.				
1.00	.5000	4.81	5.00	5.20	5.39	5.58
.05	.4762	5.05	.25	.46	.66	.86
.10	.4545	.29	.50	.72	.93	6.14
.15	.4348	.53	.75	.98	6.20	.42
.20	.4167	.77	6.00	6.24	.47	.70
.25	.4000	6.01	.25	.50	.74	.98
.30	.3846	.25	.50	.76	7.01	7.26
.35	.3704	.50	.75	7.02	.28	.54
.40	.3571	.74	7.00	.28	.54	.81
.45	.3448	.98	.25	.54	.81	8.09
.50	.3333	7.22	.50	.80	8.08	.37
.55	.3226	.46	.75	8.06	.35	.65
.60	.3125	.70	8.00	.32	.62	.93
.65	.3030	.94	.25	.58	.89	9.21
.70	.2941	8.18	.50	.84	9.16	.49
.75	.2857	.42	.75	9.10	.43	.77
.80	.2778	.66	9.00	.36	.70	10.05
.85	.2703	.90	.25	.62	.97	.33
.90	.2632	9.14	.50	.88	10.24	.61
.95	.2564	.38	.75	10.14	.51	.88

Yards per lb.	Reed. Decimal Equivalent	60	62	64	66	68
		Numbers.				
1.00	.5000	5.77	5.97	6.16	6.35	6.54
.05	.4762	6.06	6.26	.47	.67	.87
.10	.4545	.35	.56	.77	.99	7.20
.15	.4348	.64	.86	7.08	7.30	.53
.20	.4167	.93	7.16	.39	.62	.85
.25	.4000	7.22	.46	.70	.94	8.18
.30	.3846	.51	.76	8.01	8.26	.51
.35	.3704	.80	8.06	.32	.58	.84
.40	.3571	8.08	.35	.62	.89	9.16
.45	.3448	.37	.65	.93	9.21	.49
.50	.3333	.66	.95	9.24	.53	.82
.55	.3226	.95	9.25	.55	.85	10.14
.60	.3125	9.24	.55	.86	10.16	.47
.65	.3030	.53	.85	10.16	.48	.80
.70	.2941	.82	10.15	.47	.80	11.13
.75	.2857	10.11	.44	.78	11.12	.45
.80	.2778	.40	.74	11.09	.44	.78
.85	.2703	.68	11.04	.40	.76	12.11
.90	.2632	.97	.34	.71	12.07	.44
.95	.2564	11.26	.64	12.01	.39	.76

Reed.	70	72	74	76	78	80
Yards per lb.	Decimal Equiv'nt	Numbers.					
1.00	.5000	6.74	6.93	7.12	7.31	7.51	7.70
.05	.4762	7.07	7.28	.48	.68	.88	8.08
.10	.4545	.41	.62	.83	8.05	8.26	.47
.15	.4348	.75	.97	8.19	.41	.63	.85
.20	.4167	8.08	8.32	.55	.78	9.01	9.24
.25	.4000	.42	.66	.90	9.14	.38	.63
.30	.3846	.76	9.01	9.26	.51	.76	10.01
.35	.3704	9.10	.36	.62	.88	10.14	.40
.40	.3571	.43	.70	.97	10.24	.51	.78
.45	.3448	.77	10.05	10.33	.61	.89	11.17
.50	.3333	10.11	.40	.68	.97	11.26	.55
.55	.3226	.44	.74	11.04	11.34	.64	.94
.60	.3125	.78	11.09	.40	.71	12.01	12.32
.65	.3030	11.12	.44	.75	12.07	.39	.71
.70	.2941	.45	.78	12.11	.44	.76	13.09
.75	.2857	.79	12.13	.47	.80	13.14	.48
.80	.2778	12.13	.48	.82	13.17	.52	.86
.85	.2703	.47	.82	13.18	.53	.89	14.25
.90	.2632	.80	13.17	.53	.90	14.27	.63
.95	.2564	13.14	.52	.89	14.27	.64	15.02

Reed.	82	84	86	88	90
Yards per lb.	Decimal Equivalent	Numbers.				
1.00	.5000	7.89	8.08	8.28	8.47	8.66
.05	.4762	8.29	.49	.69	.89	9.10
.10	.4545	.68	.89	9.10	9.32	.53
.15	.4348	9.08	9.30	.52	.74	.96
.20	.4167	.47	.70	.93	10.16	10.40
.25	.4000	.87	10.11	10.35	.59	.83
.30	.3846	10.26	.51	.76	11.01	11.26
.35	.3704	.66	.92	11.18	.44	.70
.40	.3571	11.05	11.32	.59	.86	12.13
.45	.3448	.45	.72	12.00	12.28	.56
.50	.3333	.84	12.13	.42	.71	13.00
.55	.3226	12.23	.53	.83	13.13	.43
.60	.3125	.63	.94	13.25	.55	.86
.65	.3030	13.02	13.34	.66	.98	14.30
.70	.2941	.42	.75	14.07	14.40	.73
.75	.2857	.81	14.15	.49	.83	15.16
.80	.2778	14.21	.56	.90	15.25	.60
.85	.2703	.60	.96	15.32	.67	16.03
.90	.2632	15.00	15.36	.73	16.10	.46
.95	.2564	.39	.77	16.14	.52	.90

Reed.		20	22	24	26	28
Yards per lb.	Decimal Equivalent	Numbers.				
2.00	.2500	3.85	4.23	4.62	5.00	5.39
.05	.2439	.94	.34	.73	.13	.52
.10	.2381	4.04	.44	.85	.25	.66
.15	.2326	.14	.55	.96	.38	.79
.20	.2273	.23	.66	5.08	.50	.93
.25	.2222	.33	.76	.20	.63	6.06
.30	.2174	.42	.87	.31	.75	.20
.35	.2128	.52	.97	.43	.88	.33
.40	.2083	.62	5.08	.54	6.00	·47
.45	.2041	.71	.19	.66	.13	.60
.50	.2000	.81	.29	.77	.25	.74
.55	.1961	.91	.40	.89	.38	.87
.60	.1923	5.00	.50	6.00	.50	7.01
.65	.1887	.10	.61	.12	.63	·14
.70	.1852	.20	.72	.24	.75	.28
.75	.1818	.29	.82	.35	.87	.41
.80	.1786	.39	.93	.47	7.00	.54
.85	.1754	.48	6.03	.58	.12	.68
.90	.1724	.58	.14	.70	.25	.81
.95	.1695	.68	.24	.81	.37	.95

Reed.		30	32	34	36	38
Yards per lb.	Decimal Equivalent	Numbers.				
2.00	.2500	5.77	6.16	6.54	6.93	7.31
.05	.2439	.92	.31	.71	7.10	.50
.10	.2381	6.06	.47	.87	.28	.68
.15	.2326	.21	.62	7.03	.45	.86
.20	.2273	.35	.77	.20	.62	8.05
.25	.2222	.50	.93	.36	.80	.23
.30	.2174	.64	7.08	.53	.97	.41
.35	.2128	.78	.24	.69	8.14	.59
.40	.2083	.93	.39	.85	.32	.78
.45	.2041	7.07	.54	8.02	.49	.96
.50	.2000	.22	.70	.18	.66	9.14
.55	.1961	.36	.85	.34	.84	.33
.60	.1923	.51	8.01	.51	9.01	.51
.65	.1887	.65	.16	.67	.18	.69
.70	.1852	.80	.32	.84	.36	.88
.75	.1818	.94	.47	9.00	.53	10.06
.80	.1786	8.08	.62	.16	.70	.24
.85	.1754	.23	.78	.33	.88	.42
.90	.1724	.37	.93	.49	10.05	.61
.95	.1695	.52	9.09	.65	.22	.79

Reed.		40	42	44	46	48
Yards per lb.	Decimal Equivalent	Numbers.				
2.00	.2500	7.70	8.08	8.47	8.85	9.24
.05	.2439	.89	.29	.68	9.08	.47
.10	.2381	8.08	.49	.89	.30	.70
.15	.2326	.28	.69	9.10	.52	.93
.20	.2273	.47	.89	.32	.74	10.16
.25	.2222	8.66	9.10	.53	.96	.39
.30	.2174	.85	.30	.74	10.18	.63
.35	.2128	9.05	.50	.95	.41	.86
.40	.2083	.24	.70	10.16	.63	11.09
.45	.2041	.43	.90	.37	.85	.32
.50	.2000	.63	10.11	.59	11.07	.55
.55	.1961	.82	.31	.80	.29	.78
.60	.1923	10.01	.51	11.01	.51	12.01
.65	.1887	.20	.71	.22	.73	.24
.70	.1852	.40	.92	.43	.96	.47
.75	.1818	10.59	11.12	.65	12.18	.71
.80	.1786	.78	.32	.86	.40	.94
.85	.1754	.97	.52	12.07	.62	13.17
.90	.1724	11.17	.72	.28	.84	.40
.95	.1695	.36	.93	.49	13.06	.63

Reed.		50	52	54	56	58
Yards per lb.	Decimal Equivalent	Numbers.				
2.00	.2500	9.63	10.00	10.40	10.78	11.16
.05	.2439	.87	.25	.66	11.05	.44
.10	.2381	10.11	.50	.92	.32	.72
.15	.2326	.35	.75	11.18	.59	12.00
.20	.2273	.59	11.00	.44	.86	.28
.25	.2222	.83	.25	.70	12.13	.56
.30	.2174	11.07	.50	.96	.40	.84
.35	.2128	.31	.75	12.22	.67	13.12
.40	.2083	.55	12.01	.48	.94	.40
.45	.2041	.79	.26	.74	13.21	.68
.50	.2000	12.03	.51	13.00	.48	.96
.55	.1961	.27	.76	.26	.75	14.24
.60	.1923	.51	13.01	.52	14.02	.51
.65	.1887	.75	.26	.78	.29	.79
.70	.1852	13.00	.51	14.04	.56	15.07
.75	.1818	.24	.76	.30	.83	.35
.80	.1786	.48	14.01	.56	15.09	.63
.85	.1754	.72	.26	.82	.36	.91
.90	.1724	.96	.51	15.08	.63	16.19
.95	.1695	14.20	.76	.34	.90	.47

Yards per lb.	Reed. Decimal Equivalent	60	62	64	66	68
		Numbers.				
2.00	.2500	11.55	11.94	12.32	12.71	13.09
.05	.2439	.84	12.23	.63	13.02	.42
.10	.2381	12.13	.53	.94	.34	.75
.15	.2326	.42	.83	13.25	.66	14.07
.20	.2273	.71	13.13	.55	.98	.40
.25	.2222	13.00	.43	.86	14.30	.73
.30	.2174	.28	.73	14.17	.61	15.06
.35	.2128	.57	14.03	.48	.93	.38
.40	.2083	.86	.32	.79	15.25	.71
.45	.2041	14.15	.62	15.09	.57	16.04
.50	.2000	.44	.92	.40	.88	.37
.55	.1961	.73	15.22	.71	16.20	.69
.60	.1923	15.02	.52	16.02	.52	17.02
.65	.1887	.31	.82	.33	.84	.35
.70	.1852	.60	16.12	.64	17.16	.68
.75	.1818	.88	.41	.94	.47	18.00
.80	.1786	16.17	.71	17.25	.79	.33
.85	.1754	.46	17.01	.56	18.11	.66
.90	.1724	.75	.31	.87	.43	.99
.95	.1695	17.04	.61	18.18	.74	19.31

Yards per lb.	Reed. Decimal Equiv'nt	70	72	74	76	78	80
		Numbers.					
2.00	.2500	13.48	13.86	14.25	14.63	15.02	15.40
.05	.2439	.81	14.21	.60	15.00	.39	.79
.10	.2381	14.15	.55	.96	.36	.77	16.17
.15	.2326	.49	.90	15.32	.73	16.14	.56
.20	.2273	.83	15.25	.67	16.10	.52	.94
.25	.2222	15.16	.59	16.03	.46	.90	17.33
.30	.2174	.50	.94	.39	.83	17.27	.71
.35	.2128	.84	16.29	.74	17.21	.65	18.10
.40	.2083	16.17	.63	17.10	.56	18.02	.48
.45	.2041	.51	.98	.45	.95	.40	.87
.50	.2000	.85	17.33	.81	18.31	.77	19.26
.55	.1961	17.18	.67	18.17	.68	19.15	.64
.60	.1923	.52	18.02	.52	19.04	.52	20.03
.65	.1887	.86	.37	.88	.41	.90	.41
.70	.1852	18.20	.71	19.24	.78	20.28	.80
.75	.1818	.53	19.06	.59	20.14	.65	21.18
.80	.1786	.74	.41	.95	.51	21.03	.57
.85	.1754	19.21	.75	20.30	.87	.40	.95
.90	.1724	.54	20.10	.66	21.24	.78	22.34
.95	.1695	.88	.45	21.02	.68	22.15	.72

	Reed.	82	84	86	88	90
Yards per lb.	Decimal Equivalent	Numbers.				
2.00	.2500	15.79	16.17	16.56	16.94	17.33
.05	.2439	16.18	.58	.97	17.37	.76
.10	.2381	58	.98	17.39	.79	18.20
.15	.2326	.97	17.39	.80	18.21	.63
.20	.2273	17.37	.79	18.21	.64	19.06
.25	.2222	.76	18.20	.63	19.06	.50
.30	.2174	18.16	.60	19.04	.49	.93
.35	.2128	.55	19.00	.46	.91	20.36
.40	.2083	.95	.41	.87	20.33	.80
.45	.2041	19.34	.81	20.29	.76	21.23
.50	.2000	.74	20.22	.70	21.18	.66
.55	.1961	20.13	.62	21.11	.60	22.10
.60	1923	.53	21.03	.53	22.03	.53
.65	.1887	.92	.43	.94	.45	.96
.70	1852	21.32	.84	22.36	.88	23.40
.75	.1818	.71	22.24	.77	23.30	.83
.80	.1786	22.11	.64	23.18	.72	24.26
.85	1754	.50	23.05	.60	24.15	.70
90	.1724	.90	.45	24.01	.57	25.13
.95	.1695	23.29	.86	.43	.99	.56

	Reed.	20	22	24	26	28
Yards per lb.	Decimal Equivalent	Numbers.				
3.00	.1667	5.77	6.35	6.93	7.51	8.08
.05	.1639	.87	.46	7.04	.63	.22
.10	.1613	.97	.56	.16	.76	.35
.15	.1587	6.06	.66	.28	.88	.49
.20	.1562	.16	.77	.39	8.01	.62
.25	.1538	.25	.88	.51	.13	.76
.30	.1515	.35	.99	.62	.26	.89
.35	.1493	.45	7.09	.74	.38	9.03
.40	.1471	.54	.20	.85	51	.16
.45	.1449	.64	.30	.97	63	.30
.50	.1429	.74	.41	8.08	.76	.43
.55	.1408	.83	.52	.20	.88	.57
.60	.1389	.93	.62	.31	9.01	.70
.65	.1370	7.02	.73	.43	.13	.84
.70	.1351	.12	.83	.55	.26	.97
.75	.1333	.22	.94	.66	.38	10.11
.80	.1316	.31	8.05	.78	.51	.24
.85	.1299	.41	.15	.89	.63	.38
.90	.1282	.51	.26	9.01	.76	.51
.95	.1266	.60	.36	.12	.89	.65

Yards per lb.	Reed. Decimal Equivalent	30	32	34	36	38
		Numbers.				
3.00	.1667	8.66	9.24	9.82	10.40	10.97
.05	.1639	.81	.39	.98	.57	11.16
.10	.1613	.95	.55	10.15	.74	.34
.15	.1587	9.10	.70	.31	.92	.52
.20	.1562	.24	.86	.47	11.09	.71
.25	.1538	.38	10.01	.64	.26	.89
.30	.1515	.53	.16	.80	.44	12.07
.35	.1493	.67	.32	.96	.61	.25
.40	.1471	.82	.47	11.13	.78	.44
.45	.1449	.96	.63	.29	.96	.62
.50	.1429	10.11	.78	.45	12.13	.80
.55	.1408	.25	.93	.62	.30	.99
.60	.1389	.39	11.09	.78	.48	13.17
.65	.1370	.54	.24	.95	.65	.35
.70	.1351	.68	.49	12.11	.82	.53
.75	.1333	.83	.55	.27	.99	.72
.80	.1316	.97	.70	.44	13.17	.90
.85	.1299	11.12	.86	.60	.34	14.08
.90	.1282	.26	12.01	.76	.51	.27
.95	.1266	.41	.17	.93	.69	.45

Yards per lb.	Reed. Decimal Equivalent	40	42	44	46	48
		Numbers.				
3.00	.1667	11.55	12.13	12.70	13.28	13.86
.05	.1639	.74	.33	.92	.51	14.09
.10	.1613	.94	.53	13.13	.73	.32
.15	.1587	12.13	.74	.34	.95	.55
.20	.1562	.32	.94	.55	14.17	.79
.25	.1538	.51	13.14	.76	.39	15.02
.30	.1515	.71	.34	.98	.61	.25
.35	.1493	.90	.54	14.19	.83	.48
.40	.1471	13.09	.75	.40	15.06	.71
.45	.1449	.28	.95	.61	.28	.94
.50	.1429	.48	14.15	.83	.50	16.17
.55	.1408	.67	.35	15.04	.72	.40
.60	.1389	.86	.56	.25	.94	.64
.65	.1370	14.05	.76	.46	16.16	.87
.70	.1351	.25	.96	.67	.39	17.10
.75	.1333	.44	15.16	.88	.61	.33
.80	.1316	.63	.36	16.10	.83	.56
.85	.1299	.83	.57	.31	17.05	.79
.90	.1282	15.02	.77	.52	.27	18.02
.95	.1266	.21	.97	.73	.49	.25

Yards per lb.	Decimal Equivalent	Reed. 50	52	54	56	58
		Numbers.				
3.00	.1667	14.44	15.02	15.60	16.17	16.75
.05	.1639	.68	.27	.86	.44	17.03
.10	.1613	.92	.52	16.12	.71	.31
.15	.1587	15.16	.77	.38	.98	.59
.20	.1562	.40	16.02	.64	17.25	.87
.25	.1538	.64	.27	.90	.52	18.15
.30	.1515	.88	.52	17.16	.79	.43
.35	.1493	16.13	.77	.42	18.06	.71
.40	.1471	.37	17.02	.68	.33	.99
.45	.1449	.61	.27	.94	.60	19.26
.50	.1429	.85	.52	18.20	.87	.54
.55	.1408	17.09	.77	.46	19.14	.82
.60	.1389	.33	18.02	.72	.41	20.10
.65	.1370	.57	.27	.98	.68	.38
.70	.1351	.81	.52	19.24	.95	.66
.75	.1333	18.05	.77	.50	20.22	.94
.80	.1316	.29	19.02	.76	.49	21.22
.85	.1299	.53	.27	20.02	.76	.50
.90	.1282	.77	.52	.28	21.03	.78
.95	.1266	19.01	.78	.54	.30	22.06

Yards per lb.	Decimal Equivalent	Reed. 60	62	64	66	68
		Numbers.				
3.00	.1667	17.33	17.91	18.48	19.06	19.64
.05	.1639	.62	18.21	.79	.38	.97
.10	.1613	.91	.50	19.10	.70	20.30
.15	.1587	18.20	.80	.41	20.02	.62
.20	.1562	.48	19.10	.72	.33	.95
.25	.1538	.77	.40	20.03	.65	21.28
.30	.1515	19.06	.70	.33	.97	.60
.35	.1493	.35	20.00	.64	21.29	.93
.40	.1471	.64	.30	.95	.60	22.26
.45	.1449	.93	.59	21.26	.92	.59
.50	.1429	20.22	.89	.57	22.24	.91
.55	.1408	.51	21.19	.87	.56	23.24
.60	.1389	.80	.49	22.18	.88	.57
.65	.1370	21.08	.79	.49	23.19	.90
.70	.1351	.37	22.09	.80	.51	24.22
.75	.1333	.66	.38	23.11	.83	.55
.80	.1316	.95	.68	.42	24.15	.88
.85	.1299	22.24	.98	.72	.46	25.21
.90	.1282	.53	23.28	24.03	.78	.53
.95	.1266	.82	.58	.34	25.10	.86

Yards per lb.	Reed. Decimal Equiv'nt	70	72	74	76	78	80
		Numbers.					
3.00	.1667	20.22	20.79	21.37	21.95	22.53	23.11
.05	.1639	.56	21.14	.73	22.32	.90	.49
.10	.1613	.89	.49	22.09	.68	23.28	.88
.15	.1587	21.23	.83	.44	23.05	.66	24.26
.20	.1562	.57	22.18	.80	.42	24.03	.65
.25	.1538	.90	.53	23.16	.78	.41	25.03
.30	.1515	22.24	.87	.51	24.15	.78	.42
.35	.1493	.58	23.22	.87	.51	25.16	.80
.40	.1471	.91	.57	24.22	.88	.53	26.19
.45	.1449	23.25	.92	.58	25.24	.91	.57
.50	.1429	.59	24.26	.94	.61	26.28	.96
.55	.1408	.93	.61	25.29	.98	.66	27.34
.60	.1389	24.26	.96	.65	26.34	27.04	.73
.65	.1370	.60	25.30	26.01	.71	.41	28.11
.70	.1351	.94	.65	.36	27.07	.79	.50
.75	.1333	25.27	26.00	.72	.44	28.16	.89
.80	.1316	.61	.34	27.07	.81	.54	29.27
.85	.1299	.95	.69	.43	28.17	.91	.66
.90	.1282	26.28	27.04	.79	.54	29.29	30.04
.95	.1266	.62	.38	28.14	.90	.67	.43

Yards per lb.	Reed. Decimal Equivalent	82	84	86	88	90
		Numbers.				
3.00	.1667	23.68	24.26	24.84	25.42	26.00
.05	.1639	24.08	.67	25.25	.84	.43
.10	.1613	.47	25.07	.67	26.27	.86
.15	.1587	.87	.48	26.08	.69	27.30
.20	.1562	25.26	.88	.50	27.11	.73
.25	.1538	.66	26.28	.91	.54	28.16
.30	.1515	26.05	.69	27.32	.96	.60
.35	.1493	.45	27.09	.74	28.38	29.03
.40	.1471	.84	.50	28.15	.81	.46
.45	.1449	27.24	.90	.57	29.23	.90
.50	.1429	.63	28.31	.98	.66	30.33
.55	.1408	28.03	.71	29.40	30.08	.76
.60	.1389	.42	29.12	.81	.50	31.20
.65	.1370	.82	.52	30.22	.93	.63
.70	.1351	29.21	.93	.64	31.35	32.06
.75	.1333	.61	30.33	31.05	.77	.50
.80	.1316	30.00	.73	.47	32.20	.93
.85	.1299	.40	31.14	.88	.62	33.36
.90	.1282	.79	.54	32.29	33.05	.80
.95	.1266	31.19	.95	.71	.47	34.23

Yards per lb.	Reed. Decimal Equivalent	20	22	24	26	28
		Numbers.				
4.00	.1250	7.70	8.47	9.24	10.01	10.78
.05	.1235	.81	.57	.35	.14	.92
.10	.1220	.89	.68	.47	.26	11.05
.15	.1205	.99	.79	.59	.39	.18
.20	.1190	8.08	.89	.70	.51	.32
.25	.1176	.18	9.00	.82	.64	.45
.30	.1163	.28	.10	.93	.76	.59
.35	.1149	.37	.22	10.05	.89	.72
.40	.1136	.47	.33	.16	11.01	.86
.45	.1124	.57	.42	.28	.14	.99
.50	.1111	.66	.53	.39	.26	12.13
.55	.1099	.76	.63	.51	.39	.26
.60	.1087	.85	.74	.62	.51	.40
.65	.1075	.95	.85	.74	.64	.53
.70	.1064	9.05	.95	.86	.76	.67
.75	.1053	.14	10.06	.97	.89	.80
.80	.1042	.24	.16	11.09	12.01	.94
.85	.1031	.34	.27	.20	.14	13.07
.90	.1020	.43	.38	.32	.26	.21
.95	.1010	.53	.48	.43	.39	.34

Yards per lb.	Reed. Decimal Equivalent	30	32	34	36	38
		Numbers.				
4.00	.1250	11.55	12.32	13.09	13.86	14.63
.05	.1235	.69	.47	.26	14.03	.82
.10	.1220	.84	.63	.42	.21	15.00
.15	.1205	.98	.78	.58	.38	.18
.20	.1190	12.13	.94	.75	.55	.36
.25	.1176	.27	13.09	.91	.73	.55
.30	.1163	.42	.24	14.07	.90	.73
.35	.1149	.56	.40	.24	15.07	.91
.40	.1136	.71	.55	.40	.25	16.10
.45	.1124	.85	.71	.57	.42	.28
.50	.1111	13.00	.86	.73	.60	.46
.55	.1099	.14	14.02	.89	.77	.65
.60	.1087	.28	.17	15.06	.94	.83
.65	.1075	.43	.32	.22	16.12	17.01
.70	.1064	.57	.48	.38	.29	.19
.75	.1053	.72	.63	.55	.46	.38
.80	.1042	.86	.79	.71	.64	.56
.85	.1031	14.01	.94	.87	.81	.74
.90	.1020	.15	15.09	16.04	.98	.93
.95	.1010	.30	.25	.20	17.16	18.11

Yards per lb.	Reed. Decimal Equivalent	40	42	44	46	48
		Numbers.				
4.00	.1250	15.40	16.17	16.94	17.71	18.50
.05	.1235	.60	.38	17.15	.94	.72
.10	.1220	.79	.58	.37	18.16	.95
.15	.1205	.98	.78	.58	.38	19.18
.20	.1190	16.17	.98	.79	.60	.41
.25	.1176	.37	17.18	18.00	.83	.64
.30	.1163	.56	.39	.21	19.05	.87
.35	.1149	.75	.59	.43	.27	20.10
.40	.1136	.94	.79	.64	.49	.33
.45	.1124	17.14	.99	.85	.71	.56
.50	.1111	.33	18.20	19.06	.93	.80
.55	.1099	.52	.40	.27	20.15	21.03
.60	.1087	.71	.60	.48	.37	.26
.65	.1075	.91	.80	.70	.59	.49
.70	.1064	18.10	19.00	.91	.82	.72
.75	.1053	.29	.21	20.12	21.04	.95
.80	.1042	.48	.41	.33	.26	22.18
.85	.1031	.68	.61	.54	.48	.41
.90	.1020	.87	.81	.76	.70	.64
.95	.1010	19.06	20.02	.97	.92	.88

Yards per lb.	Reed. Decimal Equivalent	50	52	54	56	58
		Numbers.				
4.00	.1250	19.26	20.03	20.80	21.57	22.34
.05	.1235	.50	.28	21.06	.84	.62
.10	.1220	.74	.53	.32	22.10	.90
.15	.1205	.98	.78	.58	.37	23.17
.20	.1190	20.22	21.03	.84	.64	.45
.25	.1176	.46	.28	22.10	.91	.73
.30	.1163	.70	.53	.36	23.18	24.01
.35	.1149	.94	.78	.62	.45	.29
.40	.1136	21.18	22.03	.88	.72	.57
.45	.1124	.42	.28	23.14	.99	.84
.50	.1111	.66	.53	.40	24.26	25.12
.55	.1099	.90	.78	.66	.53	.40
.60	.1087	22.14	23.03	.92	.80	.68
.65	.1075	.38	.28	24.18	25.07	.96
.70	.1064	.63	.53	.44	.34	26.24
.75	.1053	.87	.78	.70	.61	.52
.80	.1042	23.11	24.03	.96	.88	.80
.85	.1031	.35	.28	25.22	26.15	27.08
.90	.1020	.59	.53	.48	.42	.36
.95	.1010	.83	.78	.74	.69	.64

Yards per lb.	Reed. Decimal Equivalent	60	62	64	66	68
		Numbers.				
4.00	.1250	23.11	23.88	24.65	25.42	26.19
.05	.1235	.40	24.18	.96	.74	.52
.10	.1220	.68	.47	25.26	26.05	.84
.15	.1205	.97	.77	.57	.37	27.17
.20	.1190	24.26	25.07	.88	.69	.50
.25	.1176	.55	.37	26.19	27.01	.83
.30	.1163	.84	.67	.50	.32	28.15
.35	.1149	25.13	.97	.80	.64	.48
.40	.1136	.42	26.27	27.11	.96	.81
.45	.1124	.71	.56	.42	28.28	29.13
.50	.1111	26.00	.86	.73	.60	.46
.55	.1099	.28	27.16	28.04	.91	.79
.60	.1087	.57	.46	.35	29.23	30.12
.65	.1075	.86	.76	.65	.55	.45
.70	.1064	27.15	28.06	.96	.87	.77
.75	.1053	.44	.36	29.27	30.19	31.10
.80	.1042	.73	.65	.58	.50	.43
.85	.1031	28.02	.95	.89	.82	.75
.90	.1020	.31	29.25	30.19	31.14	32.08
.95	.1010	.60	.55	.50	.46	.41

Yards per lb.	Reed. Decimal Equiv'nt	70	72	74	76	78	80
		Numbers.					
4.00	.1250	26.96	27.73	28.50	29.27	30.04	30.81
.05	.1235	27.30	28.08	.86	.64	.42	31.20
.10	.1220	.63	.42	29.21	30.00	.79	.58
.15	.1205	.97	.77	.57	.37	31.17	.97
.20	.1190	28.31	29.12	.92	.73	.54	32.35
.25	.1176	.64	.46	30.28	31.10	.92	.74
.30	.1163	.98	.81	.64	.47	32.29	33.12
.35	.1149	29.32	30.16	.99	.83	.67	.51
.40	.1136	.65	.50	31.35	32.20	33.05	.89
.45	.1124	.99	.85	.71	.56	.42	34.28
.50	.1111	30.33	31.20	32.06	.93	.80	.66
.55	.1099	.67	.54	.42	33.30	34.17	35.05
.60	.1087	31.00	.89	.78	.66	.55	.43
.65	.1075	.34	32.24	33.13	34.03	.92	.82
.70	.1064	.68	.58	.49	.39	35.30	36.20
.75	.1053	32.01	.93	.84	.76	.67	.59
.80	.1042	.35	33.28	34.20	35.13	36.05	.97
.85	.1031	.69	.62	.56	.49	.43	37.36
.90	.1020	33.03	.97	.91	.86	.80	.74
.95	.1010	.36	34.32	35.27	36.22	37.18	38.13

	Reed.	82	84	86	88	90
Yards per lb.	Decimal Equivalent	Numbers.				
4.00	.1250	31.58	32.35	33.12	33.89	34.66
.05	.1235	.98	.76	.54	34.32	35.10
.10	.1220	32.37	33.16	.95	.74	.53
.15	.1205	.77	.57	34.36	35.16	.96
.20	.1190	33.16	.97	.78	.59	36.40
.25	.1176	.56	34.37	35.19	36.01	.83
.30	.1163	.95	.78	.61	.43	37.26
.35	.1149	34.35	35.18	36.02	.86	.70
.40	.1136	.74	.59	.43	37.28	38.13
.45	.1124	35.13	.99	.85	.71	.56
.50	.1111	.53	36.40	37.26	38.13	39.00
.55	.1099	.92	.80	.68	.55	.43
.60	.1087	36.32	37.21	38.09	.98	.86
.65	.1075	.71	.61	.51	39.40	40.30
.70	.1064	37.11	38.02	.92	.82	
.75	.1053	.50	.42	39.33	40.25	
.80	.1042	.90	.83	.75		
.85	.1031	38.29	39.23	40.16		
.90	.1020	.69	·64			
.95	.1010	39.08	40.04			

	Reed.	20	22	24	26	28
Yards per lb.	Decimal Equivalent	Numbers.				
5.00	.10000	9.63	10.59	11.55	12.51	13.48
.05	.09901	.72	.69	.66	.64	.61
.10	.09804	.82	.80	.78	.76	.75
.15	.09709	.91	.91	.90	.89	.88
.20	.09615	10.01	11.01	12.01	13.02	14.02
.25	.09524	.11	.12	.13	.14	.15
.30	.09434	.20	.22	.24	.27	.29
.35	.09346	.30	.33	.36	.39	.42
.40	.09259	.40	.44	.47	.52	.55
.45	.09174	.49	.54	.59	.67	.69
.50	.09091	.59	.65	.70	.80	.82
.55	.09009	.68	.75	.82	.92	.96
.60	.08929	.78	·86	.93	14.05	15.09
.65	.08850	.88	.97	13.05	.17	.23
.70	.08772	.97	12.07	.17	.30	.36
·75	.08696	11.07	.18	.28	.42	.50
.80	.08621	.17	.28	.40	.55	.63
.85	.08547	.26	.39	.51	.67	.77
.90	.08475	.36	.49	.63	.77	.90
.95	.08403	.45	.60	.75	.89	16.04

Yards per lb.	Reed. Decimal Equivalent	30	32	34	36	38
		Numbers.				
5.00	.10000	14.44	15.40	16.37	17.33	18.29
.05	.09901	.58	.56	.53	.50	.47
.10	.09804	.73	.71	.69	.68	.66
.15	.09709	.87	.87	.86	.85	.84
.20	.09615	15.02	16.02	17.02	18.02	19.02
.25	.09524	.16	.17	.18	.20	.21
.30	.09434	.31	.33	.25	.37	.39
.35	.09346	.45	.47	.41	.54	.57
.40	.09259	.60	.63	.58	.72	.76
.45	.09174	.74	.78	.74	.89	.94
.50	.09091	.88	.93	.90	19.06	20.12
.55	.09009	16.03	17.09	18.07	.24	.30
.60	.08929	.17	.24	.23	.41	.49
.65	.08850	.32	.40	.39	.58	.67
.70	.08772	.46	.55	.56	.76	.85
.75	.08696	.61	.70	.72	.93	21.04
.80	.08621	.75	.86	.89	20.10	.22
.85	.08547	.90	18.01	19.05	.28	.40
.90	.08475	17.04	.18	.31	.45	.59
.95	.08403	.18	.33	.48	.62	.77

Yards per lb.	Reed. Decimal Equivalent	40	42	44	46	48
		Numbers.				
5.00	.10000	19.26	20.22	21.18	22.14	23.11
.05	.09901	.45	.42	.39	.37	.34
.10	.09804	.64	.62	.60	.59	.57
.15	.09709	.83	.82	.81	.81	.80
.20	.09615	20.03	21.03	22.03	23.03	24.03
.25	.09524	.22	.23	.24	.25	.26
.30	.09434	.41	.43	.45	.47	.49
.35	.09346	.60	.63	.66	.69	24.72
.40	.09259	.80	.84	.87	.92	.96
.45	.09174	.99	22.04	23.09	24.14	25.19
.50	.09091	21.18	.24	.30	.36	.42
.55	.09009	.37	.44	.51	.58	.65
.60	.08929	.57	.64	.72	.80	.88
.65	.08850	.76	.85	.93	25.02	26.11
.70	.08772	.95	23.05	24.15	.24	.34
.75	.08696	22.14	.25	.36	.47	.57
.80	.08621	.34	.45	.57	.69	.80
.85	.08547	.53	.66	.78	.91	27.04
.90	.08475	.72	.86	.99	26.13	.27
.95	.08403	.91	24.06	25.21	.34	.50

	Reed.	50	52	54	56	58
Yards per lb.	Decimal Equivalent	Numbers.				
5.00	.10000	24.07	25.03	26.00	26.96	27.92
.05	.09901	.31	.28	.26	27.23	28.20
.10	.09804	.55	.53	.52	.50	.47
.15	.09709	.79	.78	.78	.77	.75
.20	.09615	25.03	26.03	27.04	28.04	29.03
.25	.09524	.27	.28	.30	.31	.31
.30	.09434	.51	.54	.56	.58	.59
.35	.09346	.75	.79	.82	.85	.87
.40	.09259	.99	27.04	28.08	29.12	30.15
.45	.09174	26.23	.29	.34	.39	.43
.50	.09091	.47	.54	.60	.66	.71
.55	.09009	.71	.79	.86	.93	.99
.60	.08929	.95	28.04	29.12	30.19	31.27
.65	.08850	27.19	.29	.38	.46	.55
.70	.08772	.43	.54	.64	.73	.83
.75	.08696	.67	.79	.90	31.00	32.10
.80	.08621	.91	29.04	30.16	.27	.39
.85	.08547	28.15	.29	.42	.54	.67
.90	.08475	.39	.54	.68	.81	.95
.95	.08403	.63	.79	.94	32.08	33.23

	Reed.	60	62	64	66	68
Yards per lb.	Decimal Equivalent	Numbers.				
5.00	.10000	28.89	29.85	30.81	31.77	32.74
.05	.09901	29.17	30.15	31.12	32.09	33.06
.10	.09804	.46	.45	.43	.41	.39
.15	.09709	.75	.74	.74	.73	.72
.20	.09615	30.04	31.04	32.04	33.05	34.05
.25	.09524	.33	.34	.35	.36	.37
.30	.09434	.62	.64	.66	.68	.70
.35	.09346	.91	.94	.97	34.00	35.03
.40	.09259	31.20	32.24	33.28	.32	.36
.45	.09174	.49	.53	.58	.63	.68
.50	.09091	.77	.83	.89	.95	36.01
.55	.09009	32.06	33.13	34.20	35.27	.34
.60	.08929	.35	.43	.51	.59	.67
.65	.08850	.64	.73	.82	.91	.99
.70	.08772	.93	34.03	35.13	36.22	37.32
.75	.08696	33.22	.33	.43	.54	.65
.80	.08621	.51	.62	.74	.86	.98
.85	.08547	.80	.92	36.05	37.18	38.30
.90	.08475	34.09	35.22	.36	.49	.63
.95	.08403	.38	.52	.67	.81	.96

	Reed.	70	72	74	76	78
Yards per lb.	Decimal Equivalent	Numbers.				
5.00	.10000	33.70	34.66	35.63	36.59	37.55
.05	.09901	34.04	35.01	.98	.95	.93
.10	.09804	.37	.36	36.34	37.32	38.30
.15	.09709	.71	.70	.69	.69	.68
.20	09615	35.05	36.05	37.05	38.05	39.05
.25	.09524	.39	.40	.41	.42	.43
.30	.09434	.72	.74	.76	.78	.81
.35	.09346	36.06	37.09	38.12	39.15	40.18
.40	.09259	.40	.44	.48	.52	.56
.45	.09174	.73	.78	.83	.88	.93
.50	.09091	37.07	38.13	39.19	40.25	41.31
.55	.09009	.41	.48	.55	.61	.68
.60	.08929	.74	.82	.90	.98	42.06
.65	.08850	38.08	39.17	40.26	41.35	.43
.70	.08772	.42	.52	.61	.71	.81
.75	.08696	.76	.86	.97	42.08	43.19
.80	.08621	39.09	40.21	41.33	.44	.56
.85	.08547	.43	.56	.68	.81	.93
.90	.08475	.77	.90	42.04	43.18	44.31
.95	.08403	40.10	41.25	.40	.54	.69

	Reed.	20	22	24	26	28
Yards per lb.	Decimal Equivalent	Numbers.				
6.00	.08333	11.55	12.71	13.86	15.02	16.17
.05	.08264	.65	.81	.98	.14	.31
.10	.08197	.74	.92	14.09	.27	.44
.15	.08130	.84	13.02	.21	.39	.58
.20	.08065	.94	.13	.32	.52	.71
.25	.08000	12.03	.24	.44	.64	.85
.30	.07937	.13	.34	.56	.77	.98
.35	.07874	.23	.45	.67	.89	17.12
.40	.07812	.32	.55	.79	16.02	.25
.45	.07752	.42	.66	.90	.14	.39
.50	.07692	.51	.77	15.02	.27	.52
.55	.07634	.61	.87	.13	.39	.66
.60	.07576	.71	.98	.25	.52	.79
.65	.07519	.80	14.08	.36	.65	.93
.70	.07463	.90	.19	.48	.77	18.06
.75	.07407	13.00	.30	.60	.90	.20
.80	.07353	.09	.40	.71	17.02	.33
.85	.07299	.19	.51	.83	.15	.47
.90	.07246	.28	.61	.94	.27	.60
.95	.07194	.38	.72	16.06	.40	.73

Yards per lb.	Reed. Decimal Equivalent	30	32	34	36	38
		Numbers.				
6.00	.08333	17.33	18.48	19.64	20.80	21.95
.05	.08264	.47	.64	.80	.97	22.13
.10	.08197	.62	.79	.97	21.14	.32
.15	.08130	.76	.95	20.13	.32	.50
.20	.08065	.91	19.10	.30	.49	.68
.25	.08000	18.05	.25	.46	.66	.87
.30	.07937	.20	.41	.62	.84	23.05
.35	.07874	.34	.56	.79	22.01	.23
.40	.07812	.48	.72	.95	.18	.42
.45	.07752	.63	.87	21.11	.36	.60
.50	.07692	.77	20.02	.28	.53	.78
.55	.07634	.92	.18	.44	.70	.96
.60	.07576	19.06	.33	.60	.88	24.15
.65	.07519	.21	.49	.77	23.05	.33
.70	.07463	.35	.64	.93	.22	.51
.75	.07407	.50	.79	22.10	.40	.70
.80	.07353	.64	.95	.26	.57	.88
.85	.07299	.78	21.10	.42	.74	25.09
.90	.07246	.93	.26	.59	.92	.25
.95	.07194	20.07	.41	.75	24.09	.43

Yards per lb.	Reed. Decimal Equivalent	40	42	44	46	48
		Numbers.				
6.00	.08333	23.11	24.26	25.42	26.56	27.73
.05	.08264	.30	.46	.63	.79	.96
.10	.08197	.49	.67	.84	27.01	28.19
.15	.08130	.68	.87	26.05	.23	.42
.20	.08065	.88	25.07	.27	.45	.65
.25	.08000	24.07	.27	.48	.67	.89
.30	.07937	.26	.48	.69	.89	29.12
.35	.07874	.46	.68	.90	28.11	.35
.40	.07812	.65	.88	27.11	.34	.58
.45	.07752	.84	26.08	.32	.56	.81
.50	.07692	25.03	.28	.54	.78	30.04
.55	.07634	.23	.49	.75	29.00	.27
.60	.07576	.42	.69	.96	.22	.50
.65	.07519	.61	.89	28.17	.44	.73
.70	.07463	.80	27.09	.38	.66	.97
.75	.07407	26.00	.30	.59	.89	31.20
.80	.07353	.19	.50	.81	30.11	.43
.85	.07299	.38	.70	29.02	.33	.66
.90	.07246	.57	.90	.23	.56	.89
.95	.07194	.77	28.10	.44	.78	32.12

Yards per lb.	Reed. Decimal Equivalent	50	52	54	56	58
		Numbers.				
6.00	.08333	28.87	30.04	31.20	32.35	33.51
.05	.08264	29.11	.29	.46	.62	.79
.10	.08197	.37	.54	.72	.89	34.07
.15	.08130	.61	.79	.98	33.16	.35
.20	.08065	.85	31.04	32.24	.43	.62
.25	.08000	30.09	.29	.50	.70	.90
.30	.07937	.33	.54	.76	.97	35.18
.35	.07874	.57	.79	33.02	34.24	.46
.40	.07812	.80	32.04	.28	.51	.74
.45	.07752	31.05	.29	.54	.78	36.02
.50	.07692	.29	.54	.80	35.05	.30
.55	.07634	.54	.79	34.06	.32	.58
.60	.07576	.79	33.05	.32	.59	.86
.65	.07519	32.03	.30	.58	.86	37.14
.70	.07463	.27	.55	.84	36.13	.42
.75	.07407	.51	.80	35.10	.40	.70
.80	.07353	.75	34.05	.36	.67	.98
.85	.07299	.99	.30	.62	.94	38.25
.90	.07246	33.23	.55	.88	37.21	.53
.95	.07194	.47	.80	36.14	.47	.81

Yards per lb.	Reed. Decimal Equivalent	60	62	64	66	68
		Numbers.				
6.00	.08333	34.66	35.82	36.97	38.13	39.29
.05	.08264	.95	36.12	37.28	.45	.61
.10	.08197	35.24	.42	.59	.77	.94
.15	.08130	.53	.71	.90	39.08	40.27
.20	.08065	.82	37.01	38.21	.40	.60
.25	.08000	36.11	.31	.52	.72	.92
.30	.07937	.40	.61	.82	40.04	41.25
.35	.07874	.69	.91	39.13	.35	.58
.40	.07812	.97	38.21	.44	.67	.90
.45	.07752	37.26	.51	.75	.99	42.23
.50	.07692	.55	.80	40.06	41.31	.56
.55	.07634	.84	39.10	.36	.63	.89
.60	.07576	38.14	.40	.67	.94	43.21
.65	.07519	.42	.70	.98	42.26	.54
.70	.07463	.71	40.00	41.29	.58	.87
.75	.07407	39.00	.30	.60	.90	44.20
.80	.07353	.29	.60	.90	43.21	.52
.85	.07299	.57	.89	42.21	.53	.85
.90	.07246	.86	41.19	.52	.85	45.18
.95	.07194	40.15	.49	.83	44.17	.51

Reed.		70	72	74	76	78
Yards per lb.	Decimal Equivalent	Numbers.				
6.00	.08333	40.44	41.60	42.75	43.91	45.06
.05	.08264	.78	.94	43.11	44.27	.43
.10	.08197	41.12	42.29	.46	.64	.81
.15	.08130	.45	.65	.82	45.01	46.19
.20	.08065	.79	.99	44.18	.37	.57
.25	.08000	42.13	43.34	.53	.74	.94
.30	.07937	.46	.69	.89	46.10	47.32
.35	.07874	.80	44.03	45.25	.47	.69
.40	.07812	43.14	.38	.60	.84	48.07
.45	.07752	.47	.73	.96	47.20	.44
.50	.07692	.81	45.07	46.32	.57	.82
.55	.07634					
.60	.07576					
.65	.07519					
.70	.07463					
.75	.07407					
.80	.07353					
.85	.07299					
.90	.07246					
.95	.07194					

Reed.		20	22	24	26	28
Yards per lb.	Decimal Equivalent	Numbers.				
7.00	.07143	13.48	14.83	16.18	17.52	18.87
.05	.07092	.57	.93	.29	.65	19.00
.10	.07042	.67	15.04	.40	.77	.14
.15	.06993	.77	.14	.52	.90	.27
.20	.06944	.86	.25	.64	18.02	.41
.25	.06897	.96	.35	.75	.15	.54
.30	.06849	14.05	.46	.87	.27	.68
.35	.06803	.15	.57	.98	.40	.81
.40	.06757	.25	.67	17.10	.52	.95
.45	.06711	.34	.78	.21	.65	20.08
.50	.06667	.44	.88	.33	.77	.22
.55	.06623	.54	.99	.44	.90	.35
.60	.06579	.63	16.10	.56	19.02	.49
.65	.06536	.73	.20	.68	.15	.62
.70	.06494	.83	.31	.79	.27	.76
.75	.06452	.92	.41	.91	.40	.89
.80	.06410	15.02	.52	18.02	.52	21.03
.85	.06369	.11	.63	.14	.65	.16
.90	.06329	.21	.73	.25	.78	.30
.95	.06289	.31	.84	.37	.90	.43

	Reed.	30	32	34	36	38
Yards per lb.	Decimal Equivalent	Numbers.				
7.00	.07143	20.22	21.56	22.91	24.26	25.61
.05	.07092	.35	.72	23.08	.44	.79
.10	.07042	.50	.87	.24	.60	.98
.15	.06993	.64	22.03	.41	.78	26.16
.20	.06944	.78	.18	.57	.96	.34
.25	.06897	.93	.33	.73	25.13	.53
.30	.06849	21.07	.49	.90	.30	.71
.35	.06803	.22	.64	24.06	.48	.89
.40	.06757	.36	.80	.23	.65	27.07
.45	.06711	.51	.95	.39	.82	.26
.50	.06667	.65	23.10	.65	26.00	.44
.55	.06623	.80	.26	.72	.17	.62
.60	.06579	.94	.41	.88	.34	.81
.65	.06536	22.08	.57	25.04	.52	.99
.70	.06494	.23	.73	.20	.70	28.17
.75	.06452	.37	.88	.37	.86	.36
.80	.06410	.52	24.03	.53	27.04	.54
.85	.06369	.66	.19	.70	.21	.72
.90	.06329	.81	.34	.86	.38	.90
.95	.06289	.95	.49	26.02	.56	29.09

	Reed.	40	42	44	46	48
Yards per lb.	Decimal Equivalent	Numbers.				
7.00	.07143	26.96	28.31	29.65	31.00	32.35
.05	.07092	27.15	.51	.87	.23	.58
.10	.07042	.34	.71	30.08	.45	.81
.15	.06993	.54	.91	.29	.67	33.05
.20	.06944	.73	29.12	.50	.89	.28
.25	.06897	.92	.32	30.71	32.11	.51
.30	.06849	28.11	.52	.92	.33	.74
.35	.06803	.31	.72	31.14	.55	.97
.40	.06757	.50	.93	.35	.78	34.20
.45	.06711	.69	30.13	.56	33.00	.43
.50	.06667	.89	.33	.77	.22	.66
.55	.06623	29.08	.53	.98	.44	.89
.60	.06579	.27	.73	32.20	.66	35.13
.65	.06536	.46	.94	.41	.88	.36
.70	.06494	.66	31.15	.62	34.10	.59
.75	.06452	.85	.34	.83	.33	.82
.80	.06410	30.04	.54	33.04	.55	36.05
.85	.06369	.23	.75	.25	.77	.28
.90	.06329	.43	.95	.47	.99	.51
.95	.06289	.62	32.15	.68	35.21	.74

Yards per lb.	Reed. Decimal Equivalent	50	52	54	56	58
		Numbers.				
7.00	.07143	33.71	35.05	36.40	37.74	39.09
.05	.07092	.94	.30	.66	38.01	.37
.10	.07042	34.18	.55	.92	.28	.65
.15	.06993	.42	.80	37.18	.55	.93
.20	.06944	.66	36.05	.44	.82	40.22
.25	.06897	.90	.30	.70	39.09	.49
.30	.06849	35.14	.55	.96	.36	.77
.35	.06803	.39	.80	38.22	.63	41.05
.40	.06757	.63	37.05	.48	.90	.33
.45	.06711	.87	.30	.74	40.17	.61
.50	.06667	36.11	.55	39.00	.44	.89
.55	06623	.35	.80	.26	.71	42.16
.60	.06579	.59	38.05	.52	.98	.44
.65	.06536	.83	.30	.78	41.25	.72
.70	.06494	37.07	.55	40.04	.52	43.00
.75	.06452	.31	.80	.30	.79	.28
.80	.06410	.55	39.05	.56	42.06	.56
.85	.06369	.79	.30	.82	.33	.84
90	.06329	38.03	.55	41.08	.60	44.12
.95	.06289	.27	.80	.34	.87	.40

Yards per lb.	Reed. Decimal Equivalent	60	62	64	66	68
		Numbers.				
7.00	.07143	40.44	41.79	43.14	44.49	
.05	.07092	.73	42.09	.45	.80	
.10	.07042	41.02	.39	.75	45.12	
.15	.06993	.31	.68	44.06	.44	
.20	.06944	.60	.98	.37	.76	
.25	.06897	.89	43.28	.68	46.07	
.30	.06849	42.17	.58	.99	.39	
.35	.06803	.46	.88	45.29	.71	
.40	.06757	.75	44.18	.60	47.03	
.45	.06711	43.04	.48	.91	.35	
.50	.06667	.33	.77	46.22	.66	
.55	.06623	.62	45.07	.53	.98	
.60	.06579	.91	.37	.84	48.29	
.65	.06536	44.20	.67	47.14	.61	
.70	.06494	.49	.97	.45	.92	
.75	06452	.77	46.27	.76	49.21	
.80	.06410	45.06	.57	48.07	.52	
.85	.06369	.35	.86	.38	.84	
.90	.06329	.64	47.16	.68	50.11	
.95	.06289	.93	.46	.99	.43	

Reed	20	22	24	26	28
Yards per lb.	Decimal Equivalent	Numbers.			
8.00	.06250	15.40	16.94	18.48	20.03	21.57
.05	.06211	.50	17.05	.60	.15	.70
.10	.06173	.60	.16	.72	.28	.84
.15	.06135	.69	.26	.83	.40	.97
.20	.06098	.79	.37	.95	.52	22.11
.25	.06061	.88	.47	19.06	.65	.24
.30	.06024	.98	.58	.18	.78	.38
.35	.05988	16.08	.69	.29	.90	.51
.40	.05952	.17	.79	.41	21.03	.64
.45	.05917	.27	.90	.52	.15	.78
.50	.05882	.37	18.00	.64	.28	.91

Reed.	30	32	34	36	38
Yards per lb.	Decimal Equivalent	Numbers.			
8.00	.06250	23.11	24.65	26.19	27.73	29.27
.05	.06211	.25	.80	.35	.90	.45
.10	.06173	.40	.96	.52	28.08	.64
.15	.06135	.54	25.11	.68	.25	.82
.20	.06098	.68	.26	.84	.42	30.00
.25	.06061	.83	.42	27.01	.60	.19
.30	.06024	.97	.57	.17	.77	.37
.35	.05988	24.12	.73	.33	.94	.55
.40	.05952	.26	.88	.50	29.12	.73
.45	.05917	.41	26.03	.66	.29	.92
.50	.05882	.55	.19	.83	.46	31.10

Yards per lb.	Decimal Equivalent	Reed. 40	42	44	46	48
		Numbers.				
8.00	.06250	30.81	32.35	33.89	35.43	36.97
.05	.06211	31.00	.55	34.10	.65	37.21
.10	.06173	.20	.76	.32	.88	.44
.15	.06135	.39	.96	.53	36.10	.67
.20	.06098	.58	33.16	.74	.32	.90
.25	.06061	.77	.36	.95	.54	38.13
.30	.06024	.97	.57	35.16	.76	.36
.35	.05988	32.16	.77	.38	.98	.59
.40	.05952	.35	.97			
.45	.05917					
.50	.05882					

Yards per lb.	Decimal Equivalent	Reed. 50	52	54	56	58
		Numbers.				
8.00	.06250	38.52	40.06	41.60	43.14	44.68
.05	.06211	.76	.31	.86	.41	.96
.10	.06173	39.00	.56	42.12	.68	45.24
.15	.06135	.24	.81	.38	.95	.52
.20	.06098	.48	41.06	.64	44.22	.81
.25	.06061	.72	.31	.90		
.30	.06024	.96	.56	43.16		
.35	.05988	40.20	.81	.42		
.40	.05952					
.45	.05917					
.50	.05882					

Yards per lb.	Decimal Equivalent	Reed. 60	62	64	66	
		Numbers.				
8.00	.06250	46.22	47.76	49.30	50.74	
.05	.06211	.51	48.06	.61	51.06	
.10	.06173	.80	.36	.92	.37	
.15	.06135	47.09	.66	50.23	.69	
.20	.06098	.37	.96	.54	52.01	
.25	.06061					
.30	.06024					
.35	.05988					
.40	.05952					
.45	.05917					
.50	.05882					

CLOTH STRUCTURAL TABLES.

To enable any person to make a cloth of heavier or lighter weight, coarser or finer pick or reed, or coarser or finer yarns than a given cloth, whilst retaining all the essential qualities of the given cloth. Or to make a range of cloths of various reeds, picks, warp and filling, all of which shall have the same essential structural qualities as the given cloth and appear like the given cloth would if magnified or diminished.

These tables are founded on the fact that yarns are in proportion to each other as the squares of their diameters.

HOW TO USE.

These tables are constructed on the fact that "If a piece of cloth is woven in any sett of reed, as for instance, a 1200 on 37 inches, and that the diameters of the warp threads and the small spaces between them are of exactly the same size. Then if we have another piece of cloth of the same texture, woven, for example, in an 1800 reed, the diameters of the warp threads being also equal to the intervening spaces, then these two sizes of cloth are said to be of the same fabric, although the one is a third finer than the other; so that when the diameters of the threads are greater than the spaces, the fabric is proportionally stouter, and the reverse when they are smaller. Now the method of determining the several grists of yarn that will preserve this uniformity of fabric through the different setts of reed depends on the following analogy:—

As the square of any given reed is
To the grists of yarn that suits that reed,
So is the square of any other sett of reed
To its respective grist for the same fabric.

The reason of this rule will evidently appear by considering the threads of warp as so many cylinders of equal length or altitude and the reed as the scale which measures the space in which a given number of these threads are contained; therefore the solidities of the threads in one sett of reed will be to those in any other sett of reed as their bases or as the squares of their diameters, by problem 11, book 12 of Euclid."

—Murphy on "The Art of Weaving," 7th edition, 1842, page 428.

In the first column of these tables is the yarn numbers, warp or filling proceeding from 1 to 40 by half numbers.

The other columns headed "Reed or Picks," contain a tabular number, the use of which is shown in the accompanying examples.

First—Warp and filling alike, reed and pick alike in a given cloth, to make a similar cloth, the warp and filling numbers of the required cloth being given. To find reed and pick.

Example.	Reed.	Warp No.	Pick.	Filling No.
Given cloth,	48	16	48	16
Required cloth,		20		20

Opposite 16, the warp and filling number of the given cloth, under 48 reed and pick, find the tabular number 21.5836.

Opposite 20, warp and filling number of required cloth, find the nearest tabular number to above, viz., 21.6376.

At the top of the column containing this tabular number is 54, the required reed and pick number.

Second—Warp and filling alike, reed and pick alike in a given cloth, to make a similar cloth, the reed and pick of the required cloth being given. To find the required warp and filling numbers.

Example.	Reed.	Warp No.	Pick.	Filling No.
Given cloth,	48	16	48	16
Required cloth,	56		56	

Opposite 16 yarn, warp and filling number of given cloth, under 48, the given reed and pick numbers, find 21.5836, the tabular number.

Under 56, the reed and pick number of the required cloth, find 21.6394, the nearest tabular number to 21.5836.

Opposite this tabular number, in the column marked "Yarn Nos." is 21½, the yarn numbers required.

THIRD—Warp and filling different numbers, reed and pick different in a given cloth, to make a similar cloth, the warp number only of the required cloth being given. To find reed, pick and filling numbers for required cloth.

Example.	Reed.	Warp No.	Pick.	Filling No.
Given cloth,	48	20	52	24
Required cloth,		25		

Opposite 20 warp, under 48 reed, find 20.6145, tabular number.

Opposite 25 warp, (required warp number,) find 20.6685, (nearest tabular number).

Above this tabular number is the required reed number, 54.

Opposite 24 filling number, under 48 reed (of given cloth), find tabular number 19.8227.

Under 54 reed (as found) opposite 19.8049 (nearest tabular number to above), find 30½, the required filling number.

Opposite 24, filling number, under 52 picks of given cloth, find tabular number 20.5180.

Opposite 30½ find 20.5740 (the nearest tabular number to above).

Above this tabular number is 59, the required pick.

FOURTH—Warp and reed different, filling and warp numbers different in a given cloth, to make a similar cloth, having picks only given. To find the required warp, reed and filling numbers.

Example.	Reed.	Warp No.	Pick.	Filling No.
Given cloth,	48	20	52	24
Required cloth,			59	

Opposite 24 filling number, under 52 picks (of given cloth), find 20.5180, tabular number.

Under 59 picks (of required cloth) find 20.5740 (nearest tabular number to above).

Opposite this tabular number is 30½, the required filling number.

Opposite 24 filling, under 48 reed, is 19.8227, tabular number.

Opposite 30½ (filling number as found) find 19.8049, tabular number.

Above this is 54, the required reed.

Opposite 20 warp number, under 48 reed (of given cloth), find 20.6145, tabular number.

Under 54, the reed as found, find 20.6685 (nearest tabular number).

Opposite this is 25, the required warp number.

FIFTH—Warp and filling different, reed and picks different in given cloth, to make a similar cloth, having reed only given. To find pick, warp and filling numbers.

Example.	Reed.	Warp No.	Pick.	Filling No.
Given cloth,	48	20	52	24
Required cloth,	54			

Opposite 20 (given warp number) under 48 (given reed) find 20.6145, tabular number.

Under 54, the required reed, opposite 20.6685 (nearest tabular number) find 25, the required warp number.

Under 48 reed, opposite 24 filling (of required cloth) find 19.8227, tabular number.

Under 54 (the required reed) find 19.8049, nearest tabular number.

Opposite this number is 30½, the filling number required.

Opposite 24 filling, under 52 picks, find 20.5180.

Opposite 30½ find 20.5740, the nearest tabular number to above, and

Above this is 59, the required pick.

SIXTH—To make a range of cloths equal to a given cloth, the reeds only for the required cloth being given. To find warp number, filling number and picks per inch.

Example.	Reed.	Warp No.	Pick.	Filling No.
Given cloth,	48	20	52	24

Required cloth to have reeds 50, 52, 54, 56, 58, 60 threads to inch.

Opposite 24 filling and under 48 reed of given cloth find tabular number 19.8227.

Opposite nearest tabular numbers, under the respective reed numbers of the required cloth, find the filling numbers.

Reeds.	Nearest Tabular No.	Filling No.
50	19.8297	26
52	19.8485	28
54	19.8049	30½
56	19.8450	32½
58	19.8279	35
60	19.8227	37½

Opposite 24 filling number, under 52 picks, find tabular number 20.5180.

Opposite respective filling numbers of required cloth as found, find nearest tabular numbers.

Above these is the required picks, viz., 54, 56, 59, 61, 63, 65.

Opposite 20, warp number, under 48 reed of given cloth, find 20.6145, tabular number.

Under the various reeds of given cloth find nearest tabular numbers.

Reed.	Nearest Tabular No.
50	20.6550
52	20.6094
54	20.5825
56	20.6502
58	20.6446
60	20.6494

Opposite these tabular numbers are the warp numbers 21½, 23½, 25½, 27, 29, 31.

NOTE—The warp and filling numbers or the reed and pick numbers in the table, can be multiplied or divided by any number, so that the same proportion is maintained throughout a problem. Thus 20 yarn number will answer for 10 or 40, that is 20 divided or multiplied by two. 40 reed for 20 reed or 80 reed.

IMPORTANT—When another value is assigned it must be maintained throughout.

Nos. Yarn.	REED OR PICK.									
	20	21	22	23	24	25	26	27	28	29
1	26.0206	26.4444	26.8485	27.2346	27.6042	27.9588	28.2995	28.6273	28.9432	29.2480
.5	24.2597	24.6885	25.0876	25.4737	25.8433	26.1979	26.5386	26.8664	27.1823	27.4871
2	23.0103	23.4341	23.8382	24.2243	24.5939	24.9485	25.2892	25.6170	25.9329	26.2377
.5	22.0412	22.4650	22.8691	23.2552	23.6248	23.9794	24.3201	24.6479	24.9638	25.2686
3	21.2494	21.6732	22.0773	22.4634	22.8330	23.1876	23.5283	23.8561	24.1720	24.4768
.5	20.5799	21.0037	21.4078	21.7939	22.1635	22.5181	22.8588	23.1866	23.5025	23.8073
4	20.0000	20.4238	20.8279	21.2140	21.5836	21.9382	22.2789	22.6067	22.9226	23.2274
.5	19.4885	19.9123	20.3164	20.7025	21.0721	21.4267	21.7674	22.0952	22.4111	22.7159
5	19.0309	19.4547	19.8588	20.2449	20.6145	20.9691	21.3098	21.6376	21.9535	22.2583
.5	18.6170	19.0408	19.4449	19.8310	20.2006	20.5552	20.8959	21.2237	21.5396	21.8444
6	18.2391	18.6629	19.0670	19.4531	19.8227	20.1773	20.5180	20.8458	21.1617	21.4665
.5	17.8915	18.3153	18.7194	19.1055	19.4751	19.8297	20.1704	20.4982	20.8141	21.1189
7	17.5693	17.9934	18.3975	18.7836	19.1532	19.5078	19.8485	20.1763	20.4922	20.7970
.5	17.2700	17.6938	18.0979	18.4840	18.8536	19.2082	19.5489	19.8767	20.1926	20.4974
8	16.9897	17.4135	17.8176	18.1937	18.5733	18.9279	19.2686	19.5964	19.9123	20.2171
.5	16.7264	17.1502	17.5543	17.9404	18.3100	18.6646	19.0053	19.3331	19.6490	19.9538
9	16.4782	16.9020	17.3061	17.6922	18.0618	18.4164	18.7571	19.0849	19.4008	19.7056
.5	16.2434	16.6672	17.0713	17.4574	17.8270	18.1816	18.5223	18.8501	19.1660	19.4708
10	16.0206	16.4444	16.8485	17.2346	17.6042	17.9588	18.2995	18.6273	18.9432	19.2480
.5	15.8087	16.2325	16.6366	17.0227	17.3923	17.7469	18.0876	18.4154	18.7313	19.0361
11	15.6067	16.0305	16.4346	16.8207	17.1903	17.5449	17.8856	18.2134	18.5293	18.8341
.5	15.4136	15.8374	16.2415	16.6276	16.9972	17.3518	17.6925	18.0203	18.3362	18.6410
12	15.2288	15.6526	16.0567	16.4428	16.8124	17.1670	17.5077	17.8355	18.1514	18.4562
.5	15.0515	15.4753	15.8794	16.2655	16.6351	16.9897	17.3304	17.6582	17.9741	18.2789
13	14.8812	15.3050	15.7091	16.0952	16.4648	16.8194	17.1601	17.4879	17.8038	18.1086
.5	14.7173	15.1411	15.5452	15.9313	16.3009	16.6555	16.9962	17.3240	17.6399	17.9447
14	14.5593	14.9831	15.3872	15.7733	16.1429	16.4975	16.8382	17.1660	17.4819	17.7867
.5	14.4069	14.8307	15.2348	15.6209	15.9905	16.3451	16.6858	17.0136	17.3295	17.6343
15	14.2597	14.6835	15.0876	15.4737	15.8433	16.1979	16.5386	16.8664	17.1823	17.4871
.5	14.1173	14.5411	14.9452	15.3313	15.7009	16.0555	16.3962	16.7240	17.0399	17.3447
16	13.9794	14.5032	14.8073	15.1934	15.5630	15.9176	16.2562	16.5861	16.9020	17.2068
.5	13.8458	14.2696	14.6737	15.0598	15.4294	15.7840	16.1247	16.4425	16.7684	17.0732
17	13.7161	14.1399	14.5430	14.9301	15.2997	15.6543	15.9950	16.3228	16.6387	16.9435
.5	13.5902	14.0040	14.4181	14.8042	15.1738	15.5284	15.8691	16.1969	16.5128	16.8176
18	13.4679	13.8917	14.2958	14.6819	15.0515	15.4061	15.7468	16.0746	16.3905	16.6953
.5	13.2589	13.6827	14.0868	14.4729	14.8425	15.1971	15.5378	15.8656	16.1815	16.4863
19	13.2331	13.6569	14.0610	14.4471	14.8167	15.1713	15.5120	15.8398	16.1557	16.4605
.5	13.1203	13.5441	13.9482	14.3343	14.7039	15.0585	15.3992	15.7270	16.0429	16.3447
20	13.0103	13.4341	13.8382	14.2243	14.5939	14.9485	15.2892	15.6170	15.9329	16.2377
.5	12.9031	13.3269	13.7310	14.1171	14.4867	14.8413	15.1820	15.5098	15.8257	16.1305
21	12.7984	13.2222	13.6263	14.0124	14.3820	14.7356	15.0773	15.4051	15.7210	16.0258
.5	12.6962	13.1200	13.5241	13.9102	14.2798	14.6344	14.9751	15.3029	15.6188	15.9236
22	12.5964	13.0202	13.4243	13.8104	14.1800	14.5346	14.8753	15.2031	15.5190	15.8238
.5	12.4988	12.9226	13.3267	13.7128	14.0824	14.4370	14.7777	15.1055	15.4214	15.7262
23	12.4033	12.8271	13.2312	13.6173	13.9869	14.3415	14.6822	15.0100	15.3259	15.6307
.5	12.3099	12.7337	13.1378	13.5239	13.8935	14.2481	14.5888	14.9166	15.2325	15.5373
24	12.2185	12.6423	13.0464	13.4325	13.8021	14.1567	14.4974	14.8252	15.1411	15.4459
.5	12.1289	12.5527	12.9568	13.3429	13.7125	14.0671	14.4078	14.7356	15.0515	15.3563
25	12.0412	12.4650	12.8691	13.2552	13.6248	13.9794	14.3201	14.6479	14.9638	15.2686
.5	11.9552	12.3790	12.7831	13.1692	13.5388	13.8934	14.2341	14.5619	14.8778	15.1826
26	11.8709	12.2947	12.6988	13.0849	13.4545	13.8091	14.1498	14.4776	14.7935	15.0983
.5	11.7811	12.2049	12.6090	12.9951	13.3647	13.7193	14.0600	14.3878	14.7037	15.0085
27	11.7070	12.1308	12.5349	12.9210	13.2906	13.6452	13.9859	14.3137	14.6296	14.9344
.5	11.6273	12.0511	12.4552	12.8413	13.2109	13.5655	13.9062	14.2340	14.5499	14.8547
28	11.5490	11.9728	12.3769	12.7630	13.1326	13.4872	13.8279	14.1557	14.4716	14.7764
.5	11.4722	11.8960	12.3001	12.6862	13.0558	13.4104	13.7511	14.0789	14.3948	14.6996
29	11.3966	11.8204	12.2245	12.6106	12.9802	13.3348	13.6755	14.0033	14.3192	14.6240
.5	11.3224	11.7462	12.1503	12.5364	12.9060	13.2606	13.6013	13.9291	14.2450	14.5498
30	11.2494	11.6732	12.0773	12.4634	12.8330	13.1876	13.5283	13.8561	14.1720	14.4768
.5	11.1776	11.6014	12.0055	12.3916	12.7612	13.1158	13.4565	13.7843	14.1002	14.4050
31	11.1070	11.5308	11.9349	12.3210	12.6906	13.0452	13.3859	13.7137	14.0296	14.3344
.5	11.0375	11.4613	11.8654	12.2515	12.6211	12.9757	13.3164	13.6442	13.9601	14.2649
32	10.9691	11.3929	11.7970	12.1831	12.5527	12.9073	13.2480	13.5758	13.8917	14.1965
.5	10.9018	11.3256	11.7297	12.1158	12.4854	12.8400	13.1807	13.5085	13.8244	14.1292
33	10.8355	11.2593	11.6634	12.0495	12.4191	12.7737	13.1144	13.4422	13.7581	14.0629
.5	10.7702	11.1940	11.5981	11.9842	12.3538	12.7084	13.0491	13.3769	13.6928	13.9976
34	10.7058	11.1296	11.5337	11.9198	12.2894	12.6440	12.9847	13.3125	13.6284	13.9332
.5	10.6424	11.0662	11.4703	11.8564	12.2260	12.5806	12.9213	13.2491	13.5650	13.8698
35	10.5799	11.0037	11.4078	11.7939	12.1635	12.5181	12.8588	13.1866	13.5025	13.8073
.5	10.5183	10.9421	11.3462	11.7323	12.1019	12.4565	12.7972	13.1250	13.4409	13.7457
36	10.4576	10.8814	11.2855	11.6716	12.0412	12.3958	12.7365	13.0643	13.3802	13.6850
.5	10.3977	10.8215	11.2256	11.6117	11.9813	12.3359	12.6766	13.0044	13.3203	13.6251
37	10.3386	10.7624	11.1665	11.5526	11.9222	12.2768	12.6175	12.9453	13.2612	13.5660
.5	10.2803	10.7041	11.1082	11.4943	11.8639	12.2185	12.5592	12.8870	13.2029	13.5077
38	10.2288	10.6466	11.0507	11.4368	11.8064	12.1610	12.5017	12.8295	13.1454	13.4502
.5	10.1660	10.5898	10.9939	11.3800	11.7496	12.1042	12.4449	12.7727	13.0886	13.3934
39	10.1100	10.5338	10.9379	11.3240	11.6936	12.0482	12.3889	12.7167	13.0326	13.3374
.5	10.0546	10.4784	10.8825	11.2686	11.6382	11.9928	12.3335	12.6613	12.9772	13.2820
40	10.0000	10.4238	10.8279	11.2140	11.5836	11.9382	12.2789	12.6067	12.9226	13.2274

Nos. Yarn.	REED OR PICK.									
	30	31	32	33	34	35	36	37	38	39
1	29.5424	29.8272	30.1030	30.3703	30.6296	30.8814	31.1261	31.3640	31.5957	31.8213
.5	27.7815	28.0663	28.3421	28.6094	28.8687	29.1205	29.3652	29.6031	29.8348	30.0504
2	26.5321	26.8169	27.0927	27.3600	27.6193	27.8711	28.1158	28.3537	28.5854	28.8110
.5	25.5630	25.8478	26.1326	26.3909	26.6502	26.9020	27.1467	27.3846	27.6163	27.8449
3	24.7712	25.0560	25.3318	25.5991	25.8584	26.1102	26.3549	26.5928	26.8245	27.0501
.5	24.1017	24.3865	24.6623	24.9296	25.1889	25.4407	25.6854	25.9233	26.1550	26.3806
4	23.5218	23.8066	24.0824	24.3497	24.6090	24.8608	25.1055	25.3434	25.5751	25.8007
.5	23.0103	23.2951	23.5709	23.8382	24.0975	24.3493	24.5940	24.8319	25.0636	25.2892
5	22.5527	22.8375	23.1133	23.3806	23.6399	23.8917	24.1364	24.3743	24.6060	24.8316
.5	22.1388	22.4236	22.6994	22.9667	23.2260	23.4778	23.7225	23.9604	24.1921	24.4177
6	21.7609	22.0457	22.3215	22.5888	22.8481	23.0999	23.3446	23.5825	23.8142	24.0398
.5	21.4133	21.6981	21.9739	22.2412	22.5005	22.7523	22.9970	23.2349	23.4666	23.6922
7	21.0914	21.3762	21.6520	21.9193	22.1786	22.4304	22.6751	22.9130	23.1447	23.3702
.5	20.7918	21.0766	21.3524	21.6197	21.8790	22.1308	22.3755	22.6134	22.8451	23.0707
8	20.5115	20.7963	21.0721	21.3394	21.5987	21.8505	22.0952	22.3331	22.5648	22.7904
.5	20.2482	20.5330	20.8088	21.0761	21.3354	21.5872	21.8319	22.0698	22.3015	22.5271
9	20.0000	20.2848	20.5606	20.8279	21.0872	21.3390	21.5837	21.8216	22.0533	22.2789
.5	19.7652	20.0500	20.3258	20.5931	20.8524	21.1042	21.3489	21.5868	21.8185	22.0441
10	19.5424	19.8272	20.1030	20.3703	20.6296	20.8814	21.1261	21.3640	21.5957	21.8213
.5	19.3305	19.6153	19.8911	20.1584	20.4177	20.6695	20.9142	21.1521	21.3838	21.6094
11	19.1285	19.4133	19.6891	19.9564	20.2157	20.4075	20.7122	20.9501	21.1818	21.4074
.5	18.9354	19.2202	19.4960	19.7633	20.0226	20.2744	20.5191	20.7570	20.9887	21.2143
12	18.7506	19.0354	19.3112	19.5785	19.8378	20.0896	20.3343	20.5722	20.8039	21.0295
.5	18.5733	18.8581	19.1339	19.4012	19.6605	19.9123	20.1517	20.3949	20.6266	20.8522
13	18.4030	18.6878	18.9036	19.2309	19.4902	19.7420	19.9867	20.2246	20.4563	20.6819
.5	18.2391	18.5239	18.7997	19.0670	19.3263	19.5781	19.8228	20.0607	20.2924	20.5180
14	18.0811	18.3659	18.6417	18.9090	19.1683	19.4201	19.6648	19.9027	20.1344	20.3600
.5	17.9287	18.2135	18.4893	18.7566	19.0159	19.2677	19.5124	19.7503	19.9820	20.2076
15	17.7815	18.0663	18.3421	18.6094	18.8687	19.1205	19.3652	19.6031	19.8348	20.0604
.5	17.6391	17.9239	18.1997	18.4670	18.7263	18.9781	19.2228	19.4607	19.6924	19.9180
16	17.5012	17.7860	18.0618	18.3291	18.5884	18.8402	19.0849	19.3228	19.5545	19.7801
.5	17.3676	17.6524	17.9282	18.1955	18.4548	18.7066	18.9513	19.1892	19.4209	19.6465
17	17.2379	17.5227	17.7985	18.0658	18.3251	18.5769	18.8216	18.9595	19.2912	19.5168
.5	17.1120	17.3968	17.6726	17.9399	18.1992	18.4510	18.6957	18.9336	19.1653	19.3909
18	16.9897	17.2745	17.5503	17.8176	18.0769	18.3287	18.5734	18.8113	19.0430	19.2686
.5	16.7807	17.0655	17.3413	17.6086	17.8679	18.1197	18.3644	18.6023	18.8340	19.0596
19	16.7549	17.0397	17.3155	17.5828	17.8421	18.0939	18.3386	18.5765	18.8082	19.0338
.5	16.6421	16.9269	17.2027	17.4700	17.7293	17.9811	18.2258	18.4637	18.6954	18.9210
20	16.5321	16.8169	17.0927	17.3600	17.6193	17.8711	18.1158	18.3537	18.5854	18.8110
.5	16.4249	16.7097	16.9855	17.2528	17.5121	17.7639	18.0086	18.2465	18.4782	18.7038
21	16.3202	16.6050	16.8808	17.1481	17.4074	17.6592	17.9039	18.1418	18.3735	18.5991
.5	16.2180	16.5028	16.7786	17.0459	17.3052	17.5570	17.8017	18.0396	18.2713	18.4969
22	16.1182	16.4030	16.6788	16.9461	17.2054	17.4572	17.7019	17.9398	18.1715	18.3971
.5	16.0206	16.3054	16.5812	16.8485	17.1078	17.3596	17.6043	17.8422	18.0739	18.2995
23	15.9251	16.2099	16.4857	16.7530	17.0123	17.2641	17.5088	17.7467	17.9784	18.2040
.5	15.8317	16.1165	16.3923	16.6596	16.9189	17.1707	17.4154	17.6533	17.8850	18.1106
24	15.7403	16.0251	16.3009	16.5682	16.8275	17.0793	17.3240	17.5619	17.7936	18.0192
.5	15.6507	15.9355	16.2113	16.4786	16.7379	16.9897	17.2344	17.4723	17.7040	17.9296
25	15.5630	15.8478	16.1236	16.3909	16.6502	16.9020	17.1467	17.3846	17.6163	17.8419
.5	15.4770	15.7618	16.0376	16.3049	16.5642	16.8160	17.0607	17.2986	17.5303	17.7559
26	15.3927	15.6775	15.9533	16.2206	16.4799	16.7317	16.9764	17.2143	17.4460	17.6716
.5	15.3029	15.5877	15.8635	16.1308	16.3901	16.6419	16.8866	17.1245	17.3562	17.5818
27	15.2288	15.5136	15.7894	16.0567	16.3160	16.5678	16.8125	17.0504	17.2821	17.5077
.5	15.1491	15.4339	15.7097	15.9770	16.2363	16.4881	16.7328	16.9707	17.2024	17.4280
28	15.0708	15.3556	15.6314	15.8987	16.1580	16.4098	16.6545	16.8924	17.1241	17.3497
.5	14.9940	15.2788	15.5546	15.8219	16.0812	16.3330	16.5977	16.8356	17.0673	17.2929
29	14.9184	15.2032	15.4790	15.7463	16.0056	16.2574	16.5021	16.7400	16.9717	17.1973
.5	14.8442	15.1290	15.4048	15.6721	15.9314	16.1832	16.4279	16.6658	16.8975	17.1231
30	14.7712	15.0560	15.3318	15.5991	15.8584	16.1102	16.3549	16.5928	16.8245	17.0501
.5	14.6994	14.9842	15.2600	15.5273	15.7866	16.0384	16.2831	16.5210	16.7527	16.9783
31	14.6288	14.9136	15.1894	15.4567	15.7160	15.9678	16.2125	16.4504	16.6821	16.9077
.5	14.5593	14.8441	15.1199	15.3872	15.6465	15.8983	16.1430	16.3869	16.6126	16.8382
32	14.4909	14.7757	15.0515	15.3188	15.5781	15.8299	16.0746	16.3125	16.5442	16.7698
.5	14.4236	14.7084	14.9842	15.2515	15.5108	15.7626	16.0073	16.2452	16.4769	16.7025
33	14.3573	14.6421	14.9179	15.1852	15.4445	15.6963	15.9410	16.1789	16.4106	16.6362
.5	14.2920	14.5768	14.8526	15.1199	15.3792	15.6310	15.8757	16.1136	16.3453	16.5709
34	14.2276	14.5124	14.7882	15.0555	15.3148	15.5666	15.8113	16.0492	16.2809	16.5065
.5	14.1642	14.4490	14.7248	14.9921	15.2514	15.5032	15.7479	15.9858	16.2175	16.4431
35	14.1017	14.3865	14.6623	14.9296	15.1889	15.4407	15.6854	15.9233	16.1550	16.3806
.5	14.0401	14.3249	14.6007	14.8680	15.1273	15.3791	15.6238	15.8617	16.0934	16.3190
36	13.9794	14.2642	14.5400	14.8073	15.0666	15.3184	15.5631	15.8010	16.0327	16.2583
.5	13.9195	14.2043	14.4801	14.7474	15.0067	15.2585	15.5032	15.7411	15.9728	16.1984
37	13.8604	14.1452	14.4210	14.6883	14.9476	15.1994	15.4441	15.6820	15.9137	16.1393
.5	13.8021	14.0869	14.3627	14.6300	14.8893	15.1411	15.3858	15.6237	15.8554	16.0810
38	13.7446	14.0294	14.3052	14.5725	14.8318	15.0836	15.3283	15.5662	15.7979	16.0235
.5	13.6878	13.9726	14.2484	14.5157	14.7750	15.0268	15.2715	15.5094	15.7411	15.9667
39	13.6318	13.9166	14.1924	14.4597	14.7190	14.9708	15.2155	15.4534	15.6851	15.9107
.5	13.5764	13.8612	14.1370	14.4043	14.6636	14.9154	15.1601	15.3980	15.6297	15.8553
40	13.5218	13.8066	14.0824	14.3497	14.6090	14.8608	15.1055	15.3434	15.5751	15.8007

Nos. Yarn.	REED OR PICK.									
	40	41	42	43	44	45	46	47	48	49
1	32.0412	32.2557	32.4650	32.6694	32.8691	33.0643	33.2552	33.4420	33.6248	33.8039
.5	30.2803	30.4948	30.7041	30.9085	31.1082	31.3034	31.4943	31.6811	31.8639	32.0430
2	29.0309	29.2454	29.4547	29.6591	29.8588	30.0540	30.2449	30.4317	30.6145	30.7936
.5	28.0618	28 2763	28.4856	28.6900	28.8897	29.0849	29.2758	29.4626	29.6454	29.8245
3	27.2700	27.4845	27.6936	27.8982	28.0979	28.2931	28.4840	28.6708	28.8536	29.0327
.5	26.6005	26.8150	27.0243	27.2287	27.4284	27.6236	27.8145	28.0013	28.1841	28.3632
4	26.0206	26.2351	26.4444	26.6488	26.8485	27.0437	27.2346	27.4214	27.6042	27.7833
.5	25.5091	25.7236	25.9329	26.1373	26.3370	26.5322	26.7231	26.9099	27.0927	27.2718
5	25.0515	25.2660	25.4753	25.6797	25.8794	26.0746	26.2655	26.4523	26.6351	26.8142
.5	24.6376	24.8521	25.0614	25.2658	25.4655	25.6607	25.8516	26.0384	26.2212	26.4003
6	24.2597	24.4742	24.6845	24.8879	25.0876	25.2828	25.4737	25.6605	25.8433	26.0224
.5	23.9121	24.1266	24.3349	24.5403	24.7400	24.9352	25.1261	25.3129	25.4957	25.6748
7	23.5902	23.8047	24.0140	24.2184	24.4181	24.6133	24.8042	24.9910	25.1738	25.3529
.5	23.2906	23.5051	23.7144	23.9188	24.1185	24.3137	24.5046	24.6914	24.8742	25.0533
8	23.0103	23.2248	23.4341	23.6385	23.8382	24.0334	24.2243	24.4111	24.5939	24.7730
.5	22.7470	22.9615	23.1708	23.3752	23.5749	23.7701	23.9610	24.1478	24.3306	24.5097
9	22.4988	22.7133	22.9226	23.1270	23.3267	23.5219	23.7128	23.8996	24.0824	24.2615
.5	22.2640	22.4785	22.6878	22.8922	23.0919	23.2871	23.4780	23.6648	23.8476	24.0267
10	22.0412	22.2557	22.4650	22.6694	22.8691	23.0643	23.2552	23.4420	23.6248	23.8039
.5	21.8293	22.0438	22.2531	22.4575	22.6572	22.8524	23.0433	23.2301	23.4129	23.5920
11	21.6273	21.8418	22.0511	22.2553	22.4552	22.6504	22.8413	23.0281	23.2109	23.3900
.5	21.4342	21.6487	21.8580	22.0624	22.2621	22.4573	22.6482	22.8350	23.0178	23.1969
12	21.2494	21.4639	21.6732	21.8776	22.0773	22.2725	22.4634	22.6502	22.8330	23.0121
.5	21.0721	21.2866	21.4959	21.7003	21.9000	22.0952	22.2861	22.4729	22.6557	22.8348
13	20.9018	21.1163	21.3256	21.5300	21.7297	21.9249	22.1158	22.3026	22.4854	22.6645
.5	20.7379	20.9524	21.1617	21.3661	21.5658	21.7610	21.9519	22.1387	22.3215	22.5006
14	20.5799	20.7944	21.0037	21.2081	21.4078	21.6030	21.7939	21.9807	22.1635	22.3426
.5	20.4275	20.6420	20.8513	21.0557	21.2554	21.4506	21.6415	21.8283	22.0111	22.1902
15	20.2803	20.4948	20.7001	20.9085	21.1082	21.3034	21.4943	21.6811	21.8639	22.0430
.5	20.1379	20.3524	20.5617	20.7661	20.9658	21.1610	21.3519	21.5387	21.7215	21.9006
16	20.0000	20.2145	20.4238	20.6282	20.8279	21.0231	21.2140	21.4008	21.5836	21.7627
.5	19.8664	20.0809	20.2902	20.4946	20.6943	20.8895	21.0804	21.2672	21.4500	21.6291
17	19.7367	19.9512	20.1605	20.3649	20.5646	20.7598	20.9507	21.1375	21.3203	21.4994
.5	19.6108	19.8253	20.0346	20.2390	20.4387	20.6339	20.8248	21.0116	21.1944	21.3735
18	19.4885	19.7030	19.9123	20.1167	20.3164	20.5116	20.7025	20.8893	21.0721	21.2512
.5	19.2795	19.4940	19.7033	19.9077	20.1074	20.3026	20.4935	20.6803	20.8631	21.0422
19	19.2537	19.4682	19.6775	19.8819	20.0816	20.2768	20.4677	20.6545	20.8373	21.0164
.5	19.1409	19.3554	19.5647	19.7691	19.9688	20.1640	20.3549	20.5417	20.7245	20.9036
20	19.0309	19.2454	19.4547	19.6591	19.8588	20.0540	20.2449	20.4317	20.6145	20.7936
.5	18.9237	19.1382	19.3475	19.5519	19.7516	19.9468	20.1377	20.3245	20.5073	20.6864
21	18.8190	19.0335	19.2428	19.4472	19.6469	19.8421	20.0330	20.2198	20.4026	20.5817
.5	18.7068	18.9313	19.1406	19.3450	19.5447	19.7399	19.9308	20.1176	20.3004	20.4795
22	18.6170	18.8315	19.0408	19.2452	19.4449	19.6401	19.8310	20.0178	20.2006	20.3797
.5	18.5194	18.7339	18.9432	19.1476	19.3473	19.5425	19.7334	19.9202	20.1030	20.2821
23	18.4239	18.6384	18.8477	19.0521	19.2518	19.4470	19.6379	19.8247	20.0075	20.1866
.5	18.3305	18.5450	18.7543	18.9587	19.1584	19.3536	19.5445	19.7313	19.9141	20.0932
24	18.2391	18.4536	18.6629	18.8673	19.0670	19.2622	19.4531	19.6399	19.8227	20.0018
.5	18.1495	18.3640	18.5733	18.7777	18.9774	19.1726	19.3635	19.5503	19.7331	19.9122
25	18.0618	18.2763	18.4856	18.6900	18.8897	19.0849	19.2758	19.4626	19.6454	19.8245
.5	17.9758	18.1903	18.3996	18.6040	18.8037	18.9989	19.1898	19.3766	19.5594	19.7385
26	17.8915	18.1060	18.3153	18.5197	18.7194	18.9146	19.1055	19.2923	19.4751	19.6542
.5	17.8017	18.0162	18.2255	18.4299	18.6295	18.8248	19.0157	19.2025	19.3853	19.5644
27	17.7276	17.9421	18.1514	18.3558	18.5555	18.7507	18.9416	19.1284	19.3112	19.4903
.5	17.6479	17.8624	18.0717	18.2761	18.4758	18.6710	18.8619	19.0487	19.2315	19.4406
28	17.5696	17.7841	17.9934	18.1978	18.3975	18.5927	18.7836	18.9704	19.1532	19.3323
.5	17.4928	17.7073	17.9166	18.1210	18.3207	18.5159	18.7068	18.8936	19.0764	19.2555
29	17.4172	17.6317	17.8410	18.0454	18.2451	18.4403	18.6312	18.8180	19.0008	19.1799
.5	17.3430	17.5575	17.7668	17.9712	18.1709	18.3661	18.5570	18.7438	18.9266	19.1057
30	17.2700	17.4845	17.6938	17.8982	18.0979	18.2931	18.4840	18.6708	18.8536	19.0327
.5	17.1982	17.4127	17.6220	17.8264	18.0261	18.2213	18.4122	18.5990	18.7818	18.9609
31	17.1276	17.3421	17.5514	17.7558	17.9555	18.1507	18.3416	18.5284	18.7112	18.8903
.5	17.0581	17.2726	17.4819	17.6863	17.8860	18.0812	18.2721	18.4589	18.6417	18.8208
32	16.9897	17.2042	17.4135	17.6179	17.8176	18.0128	18.2037	18.3905	18.5733	18.7524
.5	16.9224	17.1369	17.3462	17.5506	17.7503	17.9455	18.1364	18.3232	18.5060	18.6851
33	16.8561	17.0706	17.2799	17.4843	17.6840	17.8782	18.0701	18.2569	18.4397	18.6188
.5	16.7908	17.0053	17.2146	17.4190	17.6187	17.8139	18.0048	18.1916	18.3744	18.5537
34	16.7264	16.9409	17.1502	17.3546	17.5543	17.7495	17.9404	18.1272	18.3100	18.4891
.5	16.6630	16.8775	17.0868	17.2912	17.4909	17.6861	17.8770	18.0638	18.2466	18.4257
35	16.6005	16.8150	17.0243	17.2287	17.4284	17.6236	17.8145	18.0013	18.1841	18.3632
.5	16.5389	16.7534	16.9627	17.1671	17.3668	17.5620	17.7529	17.9397	18.1225	18.3016
36	16.4782	16.6927	16.9020	17.1064	17.3061	17.5013	17.6922	17.8790	18.0618	18.2409
.5	16.4183	16.6328	16.8421	17.0465	17.2462	17.4414	17.6323	17.8191	18.0019	18.1810
37	16.3592	16.5737	16.7830	16.9874	17.1871	17.3823	17.5732	17.7600	17.9428	18.1219
.5	16.3009	16.5154	16.7247	16.9291	17.1288	17.3240	17.5149	17.7017	17.8845	18.0636
38	16.2434	16.4579	16.6672	16.8716	17.0713	17.2665	17.4574	17.6442	17.8270	18.0061
.5	16.1866	16.4011	16.6104	16.8148	17.0145	17.2097	17.4006	17.5874	17.7702	17.9493
39	16.1306	16.3451	16.5344	16.7588	16.9585	17.1537	17.3446	17.5314	17.7142	17.8933
.5	16.0752	16.2897	16.4990	16.7034	16.9031	17.0983	17.2892	17.4760	17.6588	17.8379
40	16.0206	16.2351	16.4444	16.6488	16.8485	17.0437	17.2346	17.4214	17.6042	17.7833

Nos. Yarn.	REED OR PICK.									
	50	51	52	53	54	55	56	57	58	59
1	33.9794	34.1514	34.3201	34.4855	34.6479	34.8073	34.9638	35.1175	35.2686	35.4170
.5	32.2185	32.3905	32.5592	32.7246	32.8870	33.0464	33.2029	33.3566	33.5077	33.6561
2	30.9691	31.1411	31.3098	31.4752	31.6376	31.7970	31.9535	32.1072	32.2583	32.4067
.5	30.0000	30.1720	30.3407	30.5061	30.6685	30.8279	30.9844	31.1381	31.2892	31.4376
3	29.2082	29.3802	29.5489	29.7143	29.8767	30.0361	30.1926	30.3463	30.4974	30.6458
.5	28.5387	28.7107	28.8794	29.0448	29.2072	29.3666	29.5231	29.6768	29.8279	29.9763
4	27.9588	28.1308	28.2995	28.4649	28.6273	28.7867	28.9432	29.0969	29.2480	29.3964
.5	27.4473	27.6193	27.7880	27.9534	28.1158	28.2752	28.4317	28.5854	28.7365	28.8849
5	26.9897	27.1617	27.3304	27.4958	27.6582	27.8176	27.9741	28.1278	28.2789	28.4273
.5	26.5758	26.7478	26.9165	27.0819	27.2443	27.4037	27.5602	27.7139	27.8650	28.0034
6	26.1979	26.3699	26.5386	26.7040	26.8664	27.0258	27.1823	27.3360	27.4871	27.6355
.5	25.8503	26.0223	26.1910	26.3564	26.5188	26.6782	26.8347	26.9884	27.1395	27.2879
7	25.5284	25.7004	25.8691	26.0345	26.1969	26.3563	26.5128	26.6665	26.8176	26.9660
.5	25.2288	25.4008	25.5695	25.7349	25.8973	26.0567	26.2132	26.3669	26.5180	26.6664
8	24.9485	25.1205	25.2892	25.4546	25.6170	25.7764	25.9329	26.0866	26.2377	26.3861
.5	24.6852	24.8572	25.0259	25.1913	25.3537	25.5131	25.6696	25.8233	25.9744	26.1228
9	24.4390	24.6090	24.7777	24.9431	25.1055	25.2649	25.4214	25.5751	25.7262	25.8746
.5	24.2022	24.3742	24.5429	24.7083	24.8707	25.0301	25.1866	25.3403	25.4914	25.6398
10	23.9794	24.1514	24.3201	24.4855	24.6479	24.8073	24.9638	25.1175	25.2686	25.4170
.5	23.7675	23.9395	24.1082	24.2736	24.4360	24.5954	24.7519	24.9056	25.0567	25.2051
11	23.5655	23.7375	23.9062	24.0716	24.2340	24.3934	24.5499	24.7036	24.8547	25.0031
.5	23.3724	23.5444	23.7131	23.8785	24.0409	24.2003	24.3568	24.5105	24.6616	24.8100
12	23.1876	23.3596	23.5283	23.6937	23.8561	24.0155	24.1720	24.3257	24.4768	24.6252
.5	23.0103	23.1823	23.3510	23.5164	23.6788	23.8382	23.9947	24.1484	24.2995	24.4479
13	22.8400	23.0120	23.1807	23.3461	23.5085	23.6679	23.8244	23.9781	24.1292	24.2776
.5	22.6761	22.8481	23.0168	23.1822	23.3446	23.5040	23.6605	23.8142	23.9653	24.1137
14	22.5181	22.6901	22.8588	23.0242	23.1866	23.3460	23.5025	23.6562	23.8073	23.9557
.5	22.3657	22.5377	22.7064	22.8718	23.0342	23.1936	23.3501	23.5038	23.6549	23.8033
15	22.2185	22.3905	22.5592	22.7246	22.8870	23.0464	23.2029	23.3566	23.5077	23.6561
.5	22.0761	22.2481	22.4168	22.5822	22.7446	22.9040	23.0605	23.2142	23.3653	23.5137
16	21.9382	22.1102	22.2789	22.4443	22.6067	22.7661	22.9226	23.0763	23.2274	23.3758
.5	21.8046	21.9766	22.1453	22.3107	22.4731	22.6325	22.7890	22.9427	23.0938	23.2422
17	21.6749	21.8469	22.0156	22.1810	22.3434	22.5028	22.6593	22.8130	22.9641	23.1125
.5	21.5490	21.7210	21.8897	22.0551	22.2175	22.3769	22.5334	22.6871	22.8382	22.9866
18	21.4267	21.5987	21.7674	21.9328	22.0952	22.2546	22.4111	22.5648	22.7159	22.8643
.5	21.2177	21.3897	21.5584	21.7238	21.8862	22.0456	22.2021	22.3558	22.5069	22.6553
19	21.1919	21.3639	21.5326	21.6980	21.8604	22.0198	22.1763	22.3300	22.4811	22.6295
.5	21.0791	21.2511	21.4198	21.5852	21.7476	21.9070	22.0635	22.2172	22.3683	22.5167
20	20.9691	21.1411	21.3098	21.4752	21.6376	21.7970	21.9535	22.1072	22.2583	22.4067
.5	20.8619	21.0339	21.2026	21.3680	21.5304	21.6898	21.8463	22.0000	22.1511	22.2995
21	20.7572	20.9292	21.0979	21.2633	21.4257	21.5851	21.7416	21.8953	22.0464	22.1948
.5	20.6550	20.8270	20.9957	21.1611	21.3235	21.4829	21.6394	21.7931	21.9442	22.0926
22	20.5552	20.7272	20.8959	21.0613	21.2237	21.3831	21.5396	21.6933	21.8444	21.9928
.5	20.4576	20.6296	20.7983	20.9637	21.1261	21.2855	21.4420	21.5957	21.7468	21.8952
23	20.3621	20.5341	20.7028	20.8682	21.0306	21.1900	21.3465	21.5002	21.6513	21.7997
.5	20.2687	20.4407	20.6094	20.7748	20.9372	21.0966	21.2531	21.4068	21.5579	21.7063
24	20.1773	20.3493	20.5180	20.6834	20.8458	21.0052	21.1617	21.3154	21.4665	21.6149
.5	20.0877	20.2597	20.4284	20.5938	20.7562	20.9156	21.0721	21.2258	21.3769	21.5253
25	20.0000	20.1720	20.3407	20.5061	20.6685	20.8279	20.9844	21.1381	21.2892	21.4376
.5	19.9140	20.0860	20.2547	20.4201	20.5825	20.7419	20.8984	21.0521	21.2032	21.3516
26	19.8297	20.0017	20.1704	20.3358	20.4982	20.6576	20.8141	20.9678	21.1189	21.2673
.5	19.7399	19.9119	20.0806	20.2460	20.4084	20.5678	20.7243	20.8780	21.0291	21.1775
27	19.6658	19.8378	20.0065	20.1719	20.3343	20.4937	20.6502	20.8039	20.9550	21.1034
.5	19.5861	19.7581	19.9268	20.0922	20.2546	20.4140	20.5705	20.7242	20.8753	21.0237
28	19.5078	19.6798	19.8485	20.0139	20.1763	20.3357	20.4922	20.6459	20.7970	20.9454
.5	19.4310	19.6030	19.7717	19.9371	20.0995	20.2589	20.4154	20.5691	20.7202	20.8686
29	19.3554	19.5274	19.6961	19.8615	20.0239	20.1833	20.3398	20.4935	20.6446	20.7930
.5	19.2812	19.4532	19.6219	19.7873	19.9497	20.1091	20.2656	20.4193	20.5704	20.7188
30	19.2082	19.3802	19.5489	19.7143	19.8767	20.0361	20.1926	20.3463	20.4974	20.6458
.5	19.1364	19.3084	19.4771	19.6425	19.8049	19.9643	20.1208	20.2745	20.4256	20.5740
31	19.0658	19.2378	19.4065	19.5719	19.7343	19.8937	20.0502	20.2039	20.3550	20.5034
.5	18.9963	19.1683	19.3370	19.5024	19.6648	19.8242	19.9807	20.1344	20.2855	20.4339
32	18.9279	19.0999	19.2686	19.4340	19.5964	19.7558	19.9123	20.0660	20.2171	20.3655
.5	18.8606	19.0326	19.2013	19.3667	19.5291	19.6885	19.8450	19.9987	20.1498	20.2982
33	18.7943	18.9663	19.1350	19.3004	19.4628	19.6222	19.7787	19.9324	20.0835	20.2319
.5	18.7290	18.9010	19.0697	19.2351	19.3975	19.5569	19.7134	19.8671	20.0182	20.1666
34	18.6646	18.8366	19.0053	19.1707	19.3331	19.4925	19.6490	19.8027	19.9538	20.1022
.5	18.6012	18.7732	18.9419	19.1073	19.2697	19.4291	19.5856	19.7393	19.8904	20.0388
35	18.5387	18.7107	18.8794	19.0448	19.2072	19.3666	19.5231	19.6768	19.8279	19.9763
.5	18.4771	18.6491	18.8178	18.9832	19.1456	19.3050	19.4615	19.6152	19.7663	19.9147
36	18.4164	18.5884	18.7571	18.9225	19.0849	19.2443	19.4008	19.5545	19.7056	19.8540
.5	18.3565	18.5285	18.6972	18.8626	19.0250	19.1844	19.3409	19.4946	19.6457	19.7941
37	18.2974	18.4694	18.6381	18.8035	18.9659	19.1253	19.2818	19.4355	19.5866	19.7350
.5	18.2391	18.4111	18.5798	18.7452	18.9076	19.0670	19.2235	19.3772	19.5283	19.6767
38	18.1816	18.3536	18.5223	18.6877	18.8501	19.0095	19.1660	19.3197	19.4708	19.6192
.5	18.1248	18.2968	18.4655	18.6309	18.7933	18.9527	19.1092	19.2629	19.4140	19.5624
39	18.0688	18.2408	18.4095	18.5749	18.7373	18.8967	19.0532	19.2069	19.3580	19.5064
.5	18.0134	18.1854	18.3541	18.5195	18.6819	18.8413	18.9978	19.1515	19.3026	19.4510
40	17.9588	18.1308	18.2995	18.4649	18.6273	18.7867	18.9432	19.0969	19.2480	19.3964

Nos. Yarn.	REED OR PICK.									
	60	61	62	63	64	65	66	67	68	69
1	35.5630	35.7066	35.8478	35.9868	36.1236	36.2583	36.3909	36.5215	36.6502	36.7770
.5	33.8.21	33.9457	34.0869	34.2259	34.3627	34.4974	34.6300	34.7606	34.7893	35.0161
2	32.5527	32.6963	32.8375	32.9765	33.1133	33.2480	33.3806	33.5112	33.6399	33.7667
.5	31.5836	31.7272	31.8694	32.0084	32.1442	32.2789	32.4115	32.5421	32.6708	32.7976
3	30.7918	30.9354	31.0766	31.2156	31.3524	31.4871	31.6197	31.7503	31.8790	32.0058
.5	30.1223	30.2659	30.4071	30.5461	30.6829	30.8176	30.9502	31.0808	31.2095	31.3363
4	29.5424	29.6860	29.8272	29.9662	30.1030	30.2377	30.3703	30.5009	30.6296	30.7564
.5	29.0339	29.1745	29.3157	29.4547	29.5915	29.7272	29.8588	29.9894	30.1171	30.2439
5	28.5734	28.7169	28.8581	28.9971	29.1339	29.2686	29.4012	29.5318	29.6605	29.7873
.5	28.1594	28.3030	28.4442	28.5832	28.7200	28.8547	28.9873	29.1183	29.2470	29.3738
6	27.7815	27.9251	28.0663	28.2053	28.3421	28.4768	28.6094	28.7400	28.8687	28.9955
.5	27.4339	27.5775	27.7187	27.8577	27.9945	28.1292	28.2618	28.3924	28.5211	28.6479
7	27.1120	27.2556	27.3968	27.5357	27.6726	27.8073	27.9399	28.0705	28.1992	28.3260
.5	26.8124	26.9560	27.0972	27.2362	27.3730	27.5077	27.6403	27.7709	27.8996	28.0264
8	26.5321	26.6757	26.8169	26.9559	27.0927	27.2274	27.3600	27.4906	27.6193	27.7461
.5	26.2688	26.4124	26.5536	26.6926	26.8294	26.9641	27.0967	27.2273	27.3560	27.4828
9	26.0206	26.1642	26.3054	26.4444	26.5812	26.7159	26.8485	26.9791	27.1078	27.2346
.5	25.7858	26.0294	26.1706	26.1796	26.3464	26 4811	26.6137	26.7443	26.8730	26.9998
10	25.5630	25.7066	25.8478	25.9868	26.1236	26.2583	26.3909	26.5215	26.6502	26.7770
.5	25.3511	25.4947	25.6359	25.7749	25.9117	26.0464	26.1790	26.3096	26.4383	26.5651
11	25.1491	25.2927	25.4339	25.5729	25.7097	25.8344	25.9770	26.1076	26.2363	26.3631
.5	24.9560	25.0996	25.2408	25.3798	25.5166	25.6513	25.7839	25.9145	26.0432	26.1700
12	24.7712	24.9148	25.0560	25.1950	25.3318	25.4665	25.5991	25.7297	25.8584	25.9852
.5	24.5939	24.7375	24.8787	25.0177	25.1545	25.2892	25.4218	25.5524	25.6811	25.8079
13	24.4236	24.5672	24.7084	24.8474	24.9842	25.1189	25.2515	25.3821	25.5108	25.6376
.5	24.2597	24.4033	24.5445	24.5835	24.8203	24.9550	25.0876	25.2182	25.3469	25.4737
14	24.1017	24.2453	24.3865	24.5255	24.6623	24.7970	24.9296	25.0602	25.1889	25.3157
.5	23.9493	24.0929	24.2341	24.3731	24.5099	24.6446	24.7772	24.9078	25.0365	25.1633
15	23.8021	23.9457	24.0869	24.2259	24.3627	24.4974	24.6300	24.7606	24.8893	25.0161
.5	23.6597	23.8033	23.9445	24.0835	24.2203	24.3550	24.4876	24.6182	24.7469	24.8737
16	23.5218	23.6654	23.8066	23.9466	24.0824	24.2071	24.3497	24.4803	24.6090	24.7358
.5	23.3882	23.5316	23.6728	23.8118	23.9488	24.0835	24.2161	24.3467	24.4754	24.6022
17	23.2585	23.4021	23.5433	23.6823	23.8291	23.9638	24.0864	24.2170	24.3457	24.4725
.5	23.1326	23.2762	23.4174	23.5564	23.6932	23.8279	23.9605	24.0911	24.2198	24.3466
18	23.0103	23.1539	23.2951	23.4341	23.5709	23.7058	23.8382	23.9688	24.0975	24.2243
.5	22.8013	22.9449	23.0861	23.2251	23.3619	23.4966	23.6292	23.7598	23.8885	24.0153
19	22.7755	22.9191	23.0603	23.1993	23.3361	23.4708	23.6034	23.7340	23.8627	23.9895
.5	22.6627	22.8063	22.9475	23.0865	23.2232	23.3570	23.4906	23.6212	23.7499	23.8767
20	22.5527	22.6963	22.8375	22.9765	23.1133	23.2470	23.3806	23.5112	23.6399	23.7667
.5	22.4455	22.5891	22.7303	22.8693	23.0061	23.1408	23.2734	23.4040	23.5327	23.6595
21	22.3408	22.4844	22.6256	22.7646	22.9014	23.0361	23.1687	23.2993	23.4280	23.5548
.5	22.2383	22.3822	22.5234	22.6624	22.7992	22.9339	23.0665	23.1971	23.3258	23.4526
22	22.1388	22.2824	22.4236	22.5626	22.6994	22.8341	22.9667	23.0973	23.2260	23.3528
.5	22.0412	22.1848	22.3260	22.4650	22.6018	22.7365	22.8691	22.9997	23.1284	23.2552
23	21.9457	22.0893	22.2305	22.3695	22.5063	22.6410	22.7736	22.9042	23.0329	23.1597
.5	21.8523	21.9959	22.1371	22.2761	22.4129	22.5476	22.6802	22.8108	22.9395	23.0663
24	21.7609	21.9045	22.0457	22.1847	22.3215	22.4562	22.5888	22.7194	22.8481	22.9749
.5	21.6713	21.8149	21.9551	22.0951	22.2319	22.3566	22.4992	22.6298	22.7585	22.8853
25	21.5836	21.7272	21.8684	22.0074	22.1442	22.2789	22.4115	22.5421	22.6708	22.7976
.5	21.4976	21.6412	21.7824	21.9214	22.0582	22.1929	22.3255	22.4561	22.5848	22.7116
26	21.4133	21.5569	21.6981	21.8371	21.9739	22.1086	22.2412	22.3718	22.5005	22.6273
.5	21.3295	21.4671	21.6083	21.7473	21.8841	22.0188	22.1514	22.2820	22.4107	22.5375
27	21.2494	21.3930	21.5342	21.6732	21.8100	21.9447	22.0773	22.2079	22.3366	22.4634
.5	21.1697	21.3133	21.4545	21.5935	21.7303	21.8650	21.9976	22.1282	22.2569	22.3837
28	21.0914	21.2350	21.3762	21.5152	21.6520	21.7867	21.9193	22.0499	22.1786	22.3054
.5	21.0146	21.1582	21.2994	21.4384	21.5752	21.7099	21.8425	21.9731	22.1018	22.2286
29	20.9390	21.0826	21.2238	21.3628	21.4996	21.6343	21.7669	21.8975	22.0262	22.1530
.5	20.8648	21.0084	21.1496	21.2886	21.4254	21.5601	21.6927	21.8233	21.9520	22.0788
30	20.7918	20.9354	21.0766	21.2156	21.3524	21.4871	21.6197	21.7503	21.8790	22.0058
.5	20.7200	20.8636	21.0048	21.1438	21.2806	21.4153	21.5479	21.6785	21.8072	21.9340
31	20.6494	20.7930	20.9342	21.0732	21.2100	21.3447	21.4773	21.6079	21.7366	21.8634
.5	20.5799	20.7235	20.8647	21.0037	21.1405	21.2752	21.4078	21.5384	21.6671	21.7939
32	20.5115	20.6551	20.7963	20.9353	21.0721	21.2068	21.3394	21.4700	21.5987	21.7255
.5	20.4442	20.5878	20.7290	20.8680	21.0048	21.1395	21.2721	21.4027	21.5314	21.6582
33	20.3779	20.5215	20.6627	20.8017	20.9385	21.0732	21.2058	21.3364	21.4651	21.5919
.5	20.3126	20.4562	20.5974	20.7364	20.8732	21.0079	21.1405	21.2711	21.3998	21.5266
34	20.2482	20.3918	20.5330	20.6720	20.8088	20.9435	21.0761	21.2067	21.3354	21.4622
.5	20.1848	20.3284	20.4696	20.6086	20.7454	20.8801	21.0127	21.1433	21.2720	21.3988
35	20.1223	20.2659	20.4071	20.5461	20.6829	20.8176	20.9502	21.0808	21.2095	21.3363
.5	20.0607	20.2043	20.3455	20.4845	20.6213	20.7560	20.8886	21.0192	21.1479	21.2747
36	20.0000	20.1436	20.2848	20.4238	20.5606	20.6953	20.8279	20.9585	21.0872	21.2140
.5	19.9401	20.0837	20.2249	20.3639	20.5007	20.6354	20.7680	20.8986	21.0273	21.1541
37	19.8810	20.0246	20.1658	20.3048	20.4416	20.5763	20.7089	20.8395	20.9682	21.0950
.5	19.8227	19.9663	20.1075	20.2465	20.3833	20.5180	20.6506	20.7812	20.9099	21.0367
38	19.7652	19.9088	20.0500	20.1890	20.3258	20.4605	20.5931	20.7237	20.8524	20.9792
.5	19.7084	19.8520	19.9932	20.1322	20.2690	20.4037	20.5363	20.6669	20.7956	20.9224
39	19.6524	19.7960	19.9372	20.0762	20.2130	20.3477	20.4803	20.6149	20.7436	20.8664
.5	19.5970	19.7406	19.8818	20.0208	20.1576	20.2923	20.4249	20.5555	20.6842	20.8110
40	19.5424	19.6860	19.8272	19.9662	20.1030	20.2377	20.3703	20.5009	20.6296	20.7564

Nos. Yarn.	REED OR PICK.									
	70	71	72	73	74	75	76	77	78	79
1	36.9020	37.0252	37.1466	37.2665	37.3846	37.5012	37.6163	37.7298	37.8419	37.9525
.5	35.1411	35.2643	35.3857	35.5056	35.6237	35.7403	35.7554	35.9689	36.0810	36.1916
2	33.8917	34.0149	34.1363	34.2562	34.3743	34.4909	34.6060	34.7195	34.8306	34.9432
.5	32.9226	33.0458	33.1672	33.2871	33.4052	33.5218	33.6369	33.7504	33.8625	33.9731
3	32.1308	32.2540	32.3754	32.4953	32.6134	32.7300	32.8451	32.9586	33.0707	33.1813
.5	31.4613	31.5845	31.7059	31.8252	31.9439	32.0605	32.1756	32.2891	32.4012	32.5118
4	30.8814	31.0046	31.1260	31.2459	31.3640	31.4806	31.5957	31.7692	31.8213	31.9319
.5	30.3699	30.4931	30.6145	30.7344	30.8525	30.9691	31.0842	31.1977	31.3098	31.4204
5	29.9123	30.0355	30.1569	30.2768	30.3949	30.5115	30.6266	30.7401	30.8522	30.9628
.5	29.4984	29.6216	29.7430	29.8629	29.9810	30.0976	30.2127	30.3262	30.4383	30.5489
6	29.1205	29.2437	29.3651	29.4850	29.6031	29.7197	29.8348	29.9483	30.0604	30.1710
.5	28.7729	28.8961	29.0175	29.1374	29.2555	29.3721	29.4872	29.6007	29.7128	29.8234
7	28.4510	28.5742	28.6956	28.8155	28.9336	29.0502	29.1653	29.2788	29.3909	29.5015
.5	28.1514	28.2746	28.3960	28.5159	28.6340	28.7506	28.8657	28.9792	29.0913	29.2019
8	27.8711	27.9943	28.1157	28.2356	28.3537	28.4703	28.5854	28.6989	28.8110	28.9216
.5	27.6078	27.7310	27.8524	27.9723	28.0904	28.2070	28.3221	28.4356	28.5477	28.6583
9	27.3596	27.4828	27.6042	27.7241	27.8422	27.9588	28.0739	28.1874	28.2995	28.4101
.5	27.1248	27.2480	27.3694	27.4893	27.6074	27.7240	27.8391	27.9526	28.0647	28.1753
10	26.9020	27.0252	27.1466	27.2665	27.3846	27.5012	27.6163	27.7298	27.8419	27.9525
.5	26.6901	26.8133	26.9347	27.0546	27.1727	27.2893	27.4044	27.5179	27.6300	27.7406
11	26.4881	26.6113	26.7327	26.8526	26.9707	27.0873	27.2024	27.3159	27.4280	27.5386
.5	26.2950	26.4182	26.5396	26.6595	26.7776	26.8942	27.0093	27.1228	27.2349	27.3455
12	26.1102	26.2334	26.3548	26.4747	26.5928	26.7094	26.8245	26.9380	27.0501	27.1607
.5	25.9329	26.0561	26.1775	26.2974	26.4155	26.5321	26.6472	26.7607	26.8728	26.9834
13	25.7626	25.8858	26.0072	26.1271	26.2452	26.3618	26.4769	26.5904	26.7025	26.8131
.5	25.5987	25.7219	25.8433	25.9632	26.0813	26.1979	26.3130	26.4265	26.5386	26.6492
14	25.4407	25.5639	25.6853	25.8052	25.9233	26.0399	26.1550	26.2685	26.3806	26.4912
.5	25.2883	25.4115	25.5329	25.6528	25.7709	25.8875	26.0026	26.1161	26.2282	26.3388
15	25.1411	25.2643	25.3857	25.5056	25.6237	25.7403	25.8554	25.9689	26.0810	26.1916
.5	24.9987	25.1219	25.2433	25.3632	25.4813	25.5979	25.7130	25.8265	25.9386	26.0492
16	24.8608	24.9840	25.1054	25.2253	25.3434	25.4600	25.5751	25.6886	25.8007	25.9113
.5	24.7272	24.8504	24.9718	25.0917	25.2098	25.3264	25.4415	25.5550	25.5671	25.7777
17	24.5975	24.7207	24.8421	24.9620	25.0801	25.1967	25.3118	25.4253	25.5374	25.6480
.5	24.4716	24.5948	24.7162	24.8361	24.9542	25.0708	25.1859	25.2994	25.4115	25.5221
18	24.3493	24.4725	24.5939	24.7138	24.8319	24.9485	25.0636	25.1771	25.2892	25.3998
.5	24.1403	24.2635	24.3849	24.5048	24.6229	24.7395	24.8546	24.9681	25.0802	25.1908
19	24.1145	24.2377	24.3591	24.4790	24.5971	24.7137	24.8288	24.9423	25.0544	25.1650
.5	24.0017	24.1249	24.2463	24.3662	24.4843	24.6009	24.7160	24.8295	24.9416	25.0422
20	23.8917	24.0149	24.1363	24.2562	24.3743	24.4909	24.6060	24.7195	24.8316	24.9422
.5	23.7845	23.9077	24.0291	24.1490	24.2671	24.3837	24.4988	24.6123	24.7244	24.8350
21	23.6798	23.8030	23.9244	24.0443	24.1624	24.2790	24.3941	24.5976	24.6192	24.7303
.5	23.5776	23.7008	23.8222	23.9421	24.0602	24.1768	24.2919	24.4054	24.5175	24.6281
22	23.4778	23.6010	23.7224	23.8423	23.9604	24.0770	24.1921	24.3056	24.4177	24.5283
.5	23.3802	23.5034	23.6248	23.7447	23.8628	23.9794	24.0945	24.2080	24.3201	24.4307
23	23.2847	23.4079	23.5293	23.6492	23.7673	23.8839	23.9990	24.1125	24.2246	24.3352
.5	23.1913	23.3145	23.4359	23.5558	23.6739	23.7905	23.9056	24.0191	24.1312	24.2418
24	23.0999	23.2231	23.3445	23.4644	23.5825	23.6991	23.8142	23.9277	24.0398	24.1504
.5	23.0103	23.1335	23.2549	23.3748	23.4929	23.6095	23.7246	23.8381	23.9502	24.0606
25	22.9226	23.0458	23.1672	23.2871	23.4052	23.5218	23.6369	23.7504	23.8625	23.9731
.5	22.8366	22.9598	23.0812	23.2011	23.3292	23.4258	23.5509	23.6644	23.7765	23.8871
26	22.7523	22.8755	22.9969	23.1168	23.2349	23.3515	23.4666	23.5801	23.6922	23.8028
.5	22.6695	22.7857	22.9071	23.0270	23.1451	23.2617	23.3768	23.4903	23.6024	23.7130
27	22.5884	22.7116	22.8330	22.9529	23.0710	23.1876	23.3027	23.4152	23.5283	23.6389
.5	22.5087	22.6319	22.7333	22.8732	22.9913	23.1079	23.2230	23.3365	23.4486	23.5592
28	22.4304	22.5536	22.6750	22.7949	22.9130	23.0296	23.1447	23.2582	23.3703	23.4809
.5	22.3536	22.4768	22.5982	22.7181	22.8362	22.9528	23.0679	23.1814	23.2935	23.4041
29	22.2780	22.4012	22.5226	22.6425	22.7606	22.8772	22.9923	23.1058	23.2179	23.3285
.5	22.2038	22.3270	22.4484	22.5683	22.6864	22.8030	22.9181	23.0316	23.1437	23.2543
30	22.1308	22.2540	22.3754	22.4953	22.6134	22.7300	22.8451	22.9586	23.0707	23.1813
.5	22.0590	22.1822	22.3036	22.4235	22.5416	22.6582	22.7733	22.8868	22.9989	23.1095
31	21.9884	22.1116	22.2330	22.3529	22.4710	22.5876	22.7027	22.8162	22.9283	23.0389
.5	21.9189	22.0421	22.1635	22.2834	22.4015	22.5181	22.6332	22.7467	22.8588	22.9694
32	21.8505	21.9737	22.0951	22.2150	22.3331	22.4497	22.5648	22.6783	22.7904	22.9010
.5	21.7832	21.9064	22.0278	22.1477	22.2658	22.3824	22.4975	22.6110	22.7231	22.8337
33	21.7169	21.8401	21.9615	22.0814	22.1995	22.3161	22.4312	22.5447	22.6568	22.7674
.5	21.6516	21.7748	21.8962	22.0161	22.1342	22.2508	22.3659	22.4794	22.5915	22.7021
34	21.5872	21.7104	21.8318	21.9517	22.0698	22.1864	22.3015	22.4150	22.5271	22.6377
.5	21.5238	21.6470	21.7684	21.8823	22.0064	22.1230	22.2381	22.3516	22.4637	22.5743
35	21.4613	21.5845	21.7059	21.8258	21.9439	22.0605	22.1756	22.2881	22.4012	22.5118
.5	21.3997	21.5229	21.6443	21.7642	21.8823	21.9989	22.1140	22.2275	22.3396	22.4502
36	21.3390	21.4622	21.5836	21.7035	21.8216	21.9382	22.0533	22.1668	22.2789	22.3895
.5	21.2791	21.4023	21.5237	21.6436	21.7617	21.8783	21.9934	22.1069	22.2190	22.3296
37	21.2200	21.3432	21.4646	21.5845	21.7026	21.8192	21.9343	22.0478	22.1599	22.2705
.5	21.1617	21.2849	21.4063	21.5262	21.6443	21.7609	21.8760	21.9895	22.1016	22.2122
38	21.1042	21.2274	21.3488	21.4687	21.5868	21.7034	21.8185	21.9320	22.0441	22.1547
.5	21.0474	21.1706	21.2920	21.4119	21.5300	21.6466	21.7617	21.8752	21.9873	22.0979
39	20.9914	21.1146	21.2360	21.3559	21.4740	21.5906	21.7057	21.8192	21.9313	22.0419
.5	20.9360	21.0592	21.1806	21.3005	21.4186	21.5352	21.6503	21.7638	21.8759	21.9865
40	20.8814	21.0046	21.1260	21.2459	21.3640	21.4806	21.5957	21.7092	21.8213	21.9319

Nos. Yarn.	REED OR PICK.									
	80	81	82	83	84	85	86	87	88	89
1	38.0618	38.1697	38.2763	38.3816	38.4856	38.5884	38.6900	38.7904	38.8897	38.9878
.5	36.3009	36.4088	36.5154	36.6207	36.7247	36.8275	36.9294	37.0295	37.1288	37.2269
2	35.0515	35.1594	35.2660	35.3713	35.4753	35.5781	35.6797	35.7801	35.8794	35.9775
.5	34.0824	34.1903	34.2969	34.4022	34.5062	34.6090	34.7186	34.8110	34.9103	35.0086
3	33.2906	33.3985	33.5051	33.6104	33.7144	33.8172	33.9188	34.0192	34.1185	34.2166
.5	32.6211	32.7290	32.8356	32.9409	33.0449	33.1477	33.2493	33.3497	33.4490	33.5471
4	32.0412	32.1491	32.2557	32.3610	32.4650	32.5678	32.6694	32.7698	32.8691	32.9672
.5	31.5297	31.6376	31.7442	31.8495	31.9535	32.0563	32.1579	32.2583	32.3576	32.4557
5	31.0721	31.1800	31.2866	31.3919	31.4959	31.5987	31.7003	31.8007	31.9000	31.9981
.5	30.6582	30.7661	30.8727	30.9780	31.0820	31.1848	31.2864	31.3869	31.4861	31.5842
6	30.2803	30.3882	30.4948	30.6001	30.7041	30.8069	30.9085	31.0089	31.1082	31.2063
.5	29.9327	30.0406	30.1472	30.2525	30.3565	30.4593	30.5609	30.6613	30.7606	30.8587
7	29.6108	29.7187	29.8253	29.9306	30.0346	30.1374	30.2390	30.3394	30.4387	30.6368
.5	29.3112	29.4191	29.5267	29.6310	29.7350	29.8378	29.9394	30.0398	30.1391	30.2372
8	29.0309	29.1388	29.2454	29.3507	29.4547	29.5575	29.6591	29.7695	29.8588	29.9569
.5	28.7676	28.8755	28.9821	29.0874	29.1914	29.2942	29.3958	29.4962	29.5955	29.6936
9	28.5194	28.6273	28.7339	28.8392	28.9432	29.0460	29.1476	29.2480	29.3473	29.4454
.5	28.2846	28.3925	28.4991	28.6044	28.7084	28.8112	28.9128	29.0132	29.1125	29.2106
10	28.0618	28.1697	28.2763	28.3816	28.4856	28.8497	28.6900	28.7904	28.8897	28.9878
.5	27.8499	27.9578	28.0644	28.1697	28.2737	28.3765	28.4781	28.5705	28.6778	28.7759
11	27.6479	27.7558	27.8624	27.9677	28.0717	28.1745	28.2761	28.3765	28.4758	28.5739
.5	27.4548	27.5627	27.6693	27.7746	27.8786	27.9814	28.0830	28.1834	28.2827	28.3808
12	27.2700	27.3779	27.4845	27.5898	27.6938	27.7966	27.8982	27.9986	28.0979	28.1960
.5	27.0927	27.2006	27.3072	27.4125	27.5165	27.6193	27.7209	27.8213	27.9206	28.0187
13	26.9224	27.0303	27.1369	27.2422	27.3462	27.3490	27.4506	27.5510	27.6503	27.7484
.5	26.7585	26.8664	26.9730	27.0783	27.1823	27.2851	27.3867	27.4871	27.5864	27.6845
14	26.6005	26.7084	26.8150	26.9203	27.0243	27.1271	27.2287	27.3291	27.4284	27.5265
.5	26.4481	26.5560	26.6626	26.7679	26.8719	26.9747	27.0763	27.1767	27.2760	27.3741
15	26.3009	26.4088	26.5154	26.6207	26.7247	26.8275	26.9291	27.0295	27.1288	27.2269
.5	26.1585	26.2664	26.3730	26.4783	26.5823	26.6851	26.7867	26.8871	26.9864	27.0845
16	26.0206	26.1285	26.2351	26.3404	26.4444	26.5472	26.6488	26.7492	26.8485	26.9466
.5	25.8870	25.9949	26.1028	26.2068	26.3108	26.4136	26.5152	26.6156	26.7149	26.8130
17	25.7573	25.8652	25.9731	26.0771	26.1811	26.2839	26.3855	26.4859	26.5852	26.6833
.5	25.6314	25.7393	25.8472	25.9512	26.0552	26.1580	26.2596	26.3600	26.4593	26.5574
18	25.5091	25.6170	25.7249	25.8289	25.9329	26.0357	26.1373	26.2378	26.3370	26.4351
.5	25.3901	25.4080	25.5159	25.6199	25.7239	25.8267	25.9283	26.0287	26.1280	26.2261
19	25.2743	25.3822	25.4901	25.5941	25.6981	25.8009	25.9025	26.0029	26.1022	26.2003
.5	25.1615	25.2694	25.3773	25.4813	25.5853	25.6881	25.7897	25.8901	25.9894	26.0875
20	25.0515	25.1594	25.2673	25.3713	25.4753	25.5781	25.6797	25.7801	25.8794	25.9775
.5	24.9443	25.0522	25.1588	25.2641	25.3681	25.4709	25.5725	25.6729	25.7722	25.8703
21	24.8398	24.9475	25.0541	25.1594	25.2634	25.3662	25.4678	25.5682	25.6675	25.7656
.5	24.7374	24.8453	24.9519	25.0572	25.1612	25.2640	25.3656	25.4660	25.5653	25.6634
22	24.6376	24.7455	24.8521	24.9574	25.0614	25.1642	25.2658	25.3662	25.4655	25.5636
.5	24.5400	24.6479	24.7545	24.8598	24.9638	25.0666	25.1682	25.2686	25.3679	25.4660
23	24.4445	24.5524	24.6590	24.7643	24.8683	24.9711	25.0727	25.1731	25.2724	25.3705
.5	24.3511	24.4590	24.5656	24.6709	24.7749	24.8777	24.9793	25.0797	25.1790	25.2771
24	24.2597	24.3676	24.4742	24.5795	24.6835	24.7863	24.8879	24.9883	25.0876	25.1857
.5	24.1701	24.2780	24.3846	24.4899	24.5939	24.6967	24.7983	24.8987	24.9980	25.0961
25	24.0824	24.1903	24.2969	24.4022	24.5062	24.6090	24.7106	24.8110	24.9103	25.0084
.5	23.9964	24.1043	24.2109	24.3162	24.4202	24.5230	24.6246	24.7250	24.8243	24.9224
26	23.9121	24.0200	24.1266	24.2319	24.3359	24.4387	24.5403	24.6407	24.7400	24.8381
.5	23.8223	23.9302	24.0368	24.1421	24.2461	24.3489	24.4505	24.5509	24.6502	24.7483
27	23.7482	23.8561	23.9627	24.0680	24.1720	24.2948	24.3764	24.4768	24.5761	24.6742
.5	23.6685	23.7764	23.8830	23.9883	24.0923	24.1951	24.2967	24.3971	24.4964	24.5945
28	23.5902	23.6981	23.8047	23.9100	24.0140	24.1168	24.2184	24.3188	24.4181	24.5162
.5	23.5134	23.6213	23.7279	23.8332	23.9372	24.0400	24.1416	24.2420	24.3413	24.4394
29	23.4378	23.5457	23.6523	23.7576	23.8616	23.9644	24.0660	24.1664	24.2657	24.3638
.5	23.3636	23.4715	23.5781	23.6834	23.7874	23.8902	23.9918	24.0922	24.1915	24.2896
30	23.2906	23.3985	23.5051	23.6104	23.7144	23.8172	23.9188	24.0192	24.1185	24.2166
.5	23.2188	23.3267	23.4333	23.5386	23.6426	23.7454	23.8470	23.9474	24.0467	24.1448
31	23.1482	23.2561	23.3627	23.4680	23.5720	23.6748	23.7764	23.8768	23.9761	24.0742
.5	23.0787	23.1866	23.2932	23.3985	23.5025	23.6053	23.7069	23.8073	23.9066	24.0047
32	23.0103	23.1182	23.2248	23.3301	23.4341	23.5369	23.6385	23.7389	23.8382	23.9363
.5	22.9430	23.0509	23.1575	23.2628	23.3668	23.4696	23.5712	23.6716	23.7709	23.8690
33	22.8767	22.9846	23.0912	23.1965	23.3005	23.4033	23.5049	23.6053	23.7046	23.8027
.5	22.8114	22.9193	23.0259	23.1312	23.2352	23.3380	23.4396	23.5400	23.6393	23.7374
34	22.7470	22.8549	22.9615	23.0668	23.1708	23.2736	23.3752	23.4756	23.5749	23.6730
.5	22.6836	22.7915	22.8981	23.0034	23.1074	23.2102	23.3118	23.4122	23.5115	23.6096
35	22.6211	22.7290	22.8356	22.9409	23.0449	23.1477	23.2493	23.3497	23.4490	23.5471
.5	22.5595	22.6674	22.7740	22.8793	22.9833	23.0861	23.1877	23.2881	23.3874	23.4855
36	22.4988	22.6067	22.7133	22.8186	22.9226	23.0254	23.1270	23.2274	23.3267	23.4248
.5	22.4389	22.5468	22.6534	22.7587	22.8627	22.9655	23.0671	23.1675	23.2668	23.3649
37	22.3798	22.4877	22.5943	22.6996	22.8036	22.9064	23.0080	23.1084	23.2077	23.3058
.5	22.3215	22.4294	22.5360	22.6413	22.7453	22.8481	22.9497	23.0501	23.1494	23.2475
38	22.2640	22.3719	22.4785	22.5838	22.6878	22.7906	22.8922	22.9926	23.0919	23.1900
.5	22.2072	22.3151	22.4217	22.5227	22.6310	22.7338	22.8354	22.9358	23.0351	23.1332
39	22.1512	22.2591	22.3657	22.4710	22.5750	22.6778	22.7794	22.8798	22.9791	23.0772
.5	22.0958	22.2037	22.3103	22.4156	22.5196	22.6224	22.7240	22.8244	22.9237	23.0218
40	22.0412	22.1491	22.2557	22.3610	22.4650	22.5678	22.6694	22.7698	22.8691	22.9672

Nos. Yarn.	REED OR PICK.										
	90	91	92	93	94	95	96	97	98	99	100
1	39.0849	39.1808	39.2758	39.3697	39.4626	39.5545	39.6454	39.7354	39.8245	39.9127	40.0000
.5	37.3240	37.4199	37.5149	37.6088	37.7017	37.7936	37.8845	37.9745	38.0636	38.1518	38.2391
2	36.0746	36.1705	36.2655	36.3594	36.4523	36.5442	36.6351	36.7251	36.8142	36.9024	36.9897
.5	35.1055	35.2014	35.2964	35.3903	35.4832	35.5751	35.6660	35.7560	35.8451	35.9333	36.0206
3	34.3137	34.4096	34.5046	34.5985	34.6914	34.7833	34.8742	34.9642	35.0533	35.1415	35.2288
.5	33.6442	33.7401	33.8351	33.9290	34.0219	34.1138	34.2047	34.2947	34.3838	34.4720	34.5593
4	33.0643	33.1602	33.2552	33.3491	33.4420	33.5339	33.6248	33.7148	33.8039	33.8921	33.9794
.5	32.5528	32.6487	32.7437	32.8376	32.9305	33.0224	33.1133	33.2033	33.2924	33.3806	33.4679
5	32.0952	32.1911	32.2861	32.3800	32.4729	32.5648	32.6557	32.7457	32.8348	32.9230	33.0103
.5	31.6813	31.7772	31.8722	31.9661	32.0590	32.1509	32.2418	32.3318	32.4209	32.5091	32.5964
6	31.3034	31.3993	31.4943	31.5882	31.6811	31.7730	31.8639	31.9539	32.0430	32.1312	32.2185
.5	30.9558	31.0517	31.1467	31.2406	31.3335	31.4254	31.5163	31.6063	31.6954	31.7836	31.8709
7	30.6339	30.7298	30.8248	30.9187	31.0116	31.1035	31.1944	31.2844	31.3735	31.4617	31.5490
.5	30.3346	30.4302	30.5252	30.6191	30.7120	30.8039	30.8948	30.9848	31.0739	31.1621	31.2494
8	30.0540	30.1499	30.2449	30.3388	30.4317	30.5236	30.6145	30.7045	30.7936	30.8818	30.9691
.5	29.7907	29.8866	29.9816	30.0755	30.1684	30.2603	30.3512	30.4412	30.5303	30.6185	30.7058
9	29.5425	29.6384	29.7334	29.8273	29.9202	30.0121	30.1030	30.1930	30.2821	30.3703	30.4576
.5	29.3077	29.4036	29.4986	29.5925	29.6854	29.7773	29.8682	29.9582	30.0473	30.1355	30.2228
10	29.0849	29.1808	29.2758	29.3697	29.4626	29.5545	29.6454	29.7354	29.8245	29.9127	30.0000
.5	28.8730	28.9689	29.0639	29.1578	29.2507	29.3426	29.4335	29.5235	29.6126	29.7008	29.7881
11	28.6710	28.7669	28.8619	28.9558	29.0487	29.1406	29.2315	29.3215	29.4106	29.4988	29.5861
.5	28.4779	28.5738	28.6688	28.7627	28.8556	28.9475	29.0384	29.1284	29.2175	29.3057	29.3930
12	28.2931	28.3890	28.4840	28.5779	28.6708	28.7627	28.8536	28.9436	29.0327	29.1209	29.2082
.5	28.1158	28.2117	28.3067	28.4006	28.4935	28.5854	28.6763	28.7663	28.8554	28.9436	29.0309
13	27.9455	28.0414	28.1364	28.2303	28.3232	28.4151	28.5060	28.5960	28.6851	28.7733	28.8606
.5	27.7816	27.8775	27.9725	28.0664	28.1593	28.2512	28.3421	28.4321	28.5212	28.6094	28.6967
14	27.6236	27.7195	27.8145	27.9084	28.0013	28.0932	28.1841	28.2741	28.3632	28.4514	28.5387
.5	27.4712	27.5671	27.6621	27.7560	27.8489	27.9408	28.0317	28.1217	28.2108	28.2990	28.3863
15	27.3240	27.4199	27.5149	27.6088	27.7017	27.7936	27.8845	27.9745	28.0636	28.1518	28.2391
.5	27.1816	27.2775	27.3725	27.4664	27.5593	27.6512	27.7421	27.8321	27.9212	28.0094	28.0967
16	27.0437	27.1396	27.2346	27.3285	27.4214	27.5133	27.6042	27.6942	27.7833	27.8715	27.9588
.5	26.9101	27.0060	27.1010	27.1949	27.2878	27.3797	27.4706	27.5606	27.6497	27.7379	27.8252
17	26.7804	26.8763	26.9713	27.0652	27.1581	27.2500	27.3409	27.4309	27.5200	27.6082	27.6955
.5	26.6545	26.7504	26.8454	26.9393	27.0322	27.1241	27.2150	27.3050	27.3941	27.4823	27.5696
18	26.5322	26.6281	26.7231	26.8170	26.9099	27.0018	27.0927	27.1827	27.2718	27.3600	27.4473
.5	26.4132	26.4191	26.5141	26.6080	26.7009	26.7928	26.8837	26.9737	27.0628	27.1510	27.2383
19	26.2974	26.3933	26.4883	26.5822	26.6751	26.7670	26.8579	26.9479	27.0370	27.1252	27.2125
.5	26.1846	26.2805	26.3755	26.4694	26.5623	26.6542	26.7451	26.8351	26.9242	27.0124	27.0997
20	26.0746	26.1705	26.2655	26.3594	26.4523	26.5442	26.6351	26.7251	26.8142	26.9024	26.9897
.5	25.9674	26.0624	26.1583	26.2522	26.3451	26.4370	26.5279	26.6179	26.7070	26.7952	26.8825
21	25.8627	25.9577	26.0536	26.1475	26.2404	26.3323	26.4232	26.5132	26.6023	26.6905	26.7778
.5	25.7605	25.8555	25.9514	26.0453	26.1382	26.2301	26.3210	26.4110	26.5001	26.5883	26.6756
22	25.6607	25.7557	25.8516	25.9455	26.0384	26.1303	26.2212	26.3112	26.4003	26.4885	26.5758
.5	25.5631	25.6581	25.7540	25.8479	25.9408	26.0327	26.1236	26.2136	26.3027	26.3909	26.4782
23	25.4676	25.5626	25.6585	25.7524	25.8453	25.9372	26.0281	26.1181	26.2072	26.2954	26.3827
.5	25.3742	25.4692	25.5651	25.6590	25.7519	25.8438	25.9347	26.0247	26.1138	26.2020	26.2893
24	25.2828	25.3778	25.4737	25.5676	25.6605	25.7524	25.8433	25.9333	26.0224	26.1106	26.1979
.5	25.1932	25.2882	25.3841	25.4780	25.5709	25.6628	25.7537	25.8437	25.9328	26.0210	26.1083
25	25.1055	25.2005	25.2964	25.3903	25.4832	25.5751	25.6660	25.7560	25.8451	25.9333	26.0206
.5	25.0195	25.1145	25.2104	25.3043	25.3972	25.4891	25.5800	25.6700	25.7591	25.8473	25.9346
26	24.9352	25.0302	25.1261	25.2200	25.3129	25.4048	25.4957	25.5857	25.6748	25.7630	25.8503
.5	24.8454	24.9404	25.0363	25.1302	25.2231	25.3150	25.4059	25.4959	25.5850	25.6732	25.7605
27	24.7713	24.8663	24.9622	25.0561	25.1490	25.2409	25.3318	25.4218	25.5100	25.5992	25.6864
.5	24.6916	24.7866	24.8825	24.9764	25.0693	25.1612	25.2521	25.3421	25.4312	25.5194	25.6067
28	24.6133	24.7083	24.8042	24.8981	24.9910	25.0829	25.1738	25.2638	25.3529	25.4411	25.5284
.5	24.5365	24.6315	24.7274	24.8213	24.9142	25.0061	25.0970	25.1870	25.2761	25.3643	25.4516
29	24.4609	24.5559	24.6518	24.7457	24.8386	24.9305	25.0214	25.1114	25.2005	25.2887	25.3760
.5	24.3867	24.4817	24.5776	24.6715	24.7644	24.8563	24.9472	25.0372	25.1263	25.2145	25.3018
30	24.3137	24.4087	24.5046	24.5985	24.6914	24.7833	24.8742	24.9642	25.0533	25.1415	25.2288
.5	24.2419	24.3369	24.4328	24.5267	24.6196	24.7115	24.8024	24.8924	24.9815	25.0697	25.1570
31	24.1713	24.2663	24.3622	24.4561	24.5490	24.6409	24.7318	24.8218	24.9109	24.9991	25.0864
.5	24.1018	24.1968	24.2927	24.3866	24.4795	24.5714	24.6623	24.7523	24.8414	24.9296	25.0169
32	24.0334	24.1284	24.2243	24.3182	24.4111	24.5030	24.5939	24.6839	24.7730	24.8612	24.9485
.5	23.9661	24.0611	24.1570	24.2509	24.3438	24.4357	24.5266	24.6166	24.7057	24.7939	24.8812
33	23.8998	23.9948	24.0907	24.1846	24.2775	24.3694	24.4603	24.5503	24.6394	24.7276	24.8149
.5	23.8345	23.9295	24.0254	24.1193	24.2122	24.3041	24.3950	24.4850	24.5741	24.6623	24.7496
34	23.7701	23.8651	23.9610	24.0549	24.1478	24.2397	24.3306	24.4206	24.5097	24.5979	24.6852
.5	23.7067	23.8017	23.8976	23.9915	24.0844	24.1763	24.2672	24.3572	24.4463	24.5345	24.6218
35	23.6442	23.7392	23.8351	23.9290	24.0219	24.1138	24.2047	24.2947	24.3838	24.4720	24.5593
.5	23.5826	23.6776	23.7735	23.8674	23.9603	24.0522	24.1431	24.2331	24.3222	24.4104	24.4977
36	23.5219	23.6169	23.7128	23.8067	23.8996	23.9915	24.0824	24.1724	24.2615	24.3497	24.4370
.5	23.4620	23.5570	23.6529	23.7468	23.8397	23.9316	24.0225	24.1125	24.2016	24.2898	24.3771
37	23.4029	23.4979	23.5938	23.6877	23.7806	23.8725	23.9634	24.0534	24.1425	24.2307	24.3180
.5	23.3446	23.4396	23.5355	23.6294	23.7223	23.8142	23.9051	23.9951	24.0842	24.1724	24.2597
38	23.2871	23.3821	23.4780	23.5719	23.6648	23.7567	23.8476	23.9376	24.0267	24.1149	24.2022
.5	23.2303	23.3253	23.4212	23.5151	23.6080	23.6999	23.7908	23.8808	23.9699	24.0581	24.1454
39	23.1743	23.2693	23.3652	23.4591	23.5520	23.6439	23.7348	23.8248	23.9139	24.0021	24.0894
.5	23.1189	23.2139	23.3098	23.4037	23.4966	23.5885	23.6794	23.7694	23.8585	23.9467	24.0340
40	23.0643	23.1593	23.2552	23.3491	23.4420	23.5339	23.6248	23.7148	23.8039	23.8921	23.9794

At request of an interested overseer we are printing Multiplication Tables giving products of numbers 1 to 100 multiplied against numbers 1 to 12 inclusive. To use the table, find the number to be multiplied in the left column and follow its horizontal line till a number is reached directly under the multiplier. For instance, to multiply 46×9, find 46 in left column and follow along to column headed 9 where the answer, 414 appears.

To get products not in table simply subdivide into divisions that are in table and multiply sections together by table.

For instance, to multiply 97×4326

Note that 4326 is made up as follows:

4000
300
20
6

Find 97×4 in table and add three ciphers = 388000
97×3 " " " " two " = 29100
97×2 " " " " one " = 1940
97×6 " " = 582

add together = 419622 answer

Another example: to multiply 1257×6709

Subdivide both as follows:

1200 6700 6000
57 9 700
9

1200×6700 in table = 8040000
1200× 9 " = 10800
57×6000 " = 342000
57× 700 " = 39900
57× 9 " = 513

add = 8433213 answer

There are other methods and uses which will readily suggest themselves. There are practical machines now for sale which are of great assistance for numerous or complicated mathematical computation.

To multiply fractions reduce first to decimals. The following tables may assist :

1-16 =	.0625
2-16 = 1-8 =	.125
3-16 =	.1875
4-16 = 2-8 = 1-4 =	.25
5-16 =	.3125
6-16 = 3-8 =	.375
7-16 =	.4375
8-16 = 4-8 = 2-4 = 1-2 =	.5
9-16 =	.5625
10-16 = 5-8 =	.625
11-16 =	.6875
12-16 = 6-8 = 3-4 =	·75
13-16 =	.8125
14-16 = 7-8 =	.875
15-16 =	.9375

1-12 =	.0833+
2-12 = 1-6 =	.1666+
3-12 = 1-4 =	.25
4-12 = 2-6 = 1-3 =	.3333+
5-12 =	.4166+
6-12 = 3-6 = 1-2 =	.5
7-12 =	.5833+
8-12 = 4-6 = 2-3 =	.6666+
9-12 = 3-4 =	.75
10-12 = 5-6 =	.8333+
11-12 =	.9166+

Example : to find product of 2 3-4×8 1-2

2 3-4 = 2.75 subdivide 2.70 8.0
8 1-2 = 8.5 .05 .5

Point off as many decimal places as there are figures on right side of point in both multiplier and multiplicand.

2.70× 8.0 by table = 21.600
2.70×.5 " 1.350
.05× 8.0 " .040
.05×.5 " .025

add = 23.015 answer

To multiply fractions not reduced to decimals multiply the numerators and the denominators by each other, thus :

$$13\text{-}16 \times 5\text{-}8 = \frac{13 \times 5}{16 \times 8} = \frac{65}{122} \text{ answer}$$

Decimal equivalents of money :

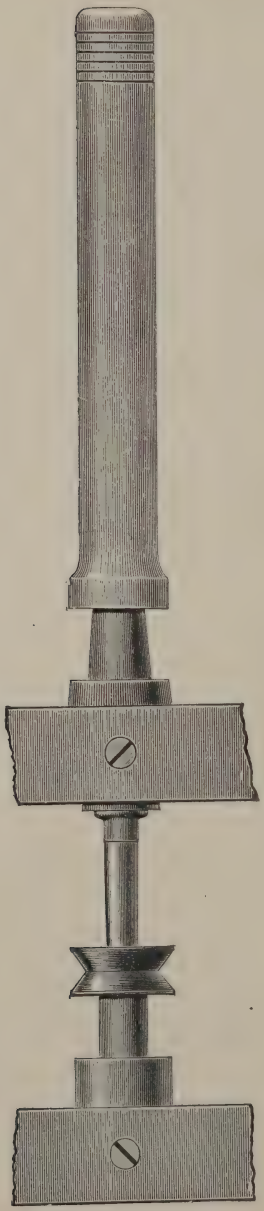
one cent	= $ .01
ten cents	= $ .10
twenty-five cents	= $ .25
fifty cents	= $ .50
seventy-five cents	= $ .75
one dollar	= $1.00

Percentage is a very common method of expressing values but very often misunderstood. Percentage is a ratio between the arbitrarily chosen number 100 and the percentage itself. For instance, 10 is 10 per cent. of 100 but it is 20 per cent. of 50 because 20 bears the same ratio to 10 that 100 does to 50.

If a loom runs 189 picks per minute it is 8 per cent. faster than one which runs at 175 because there are 14 picks difference, and 14 is to 175 as 8 is to 100. To find the answer we divide 14 by 175 and disregard the decimal point.

1	2	3	4	5	6	7	8	9	10	11	12
2	4	6	8	10	12	14	16	18	20	22	24
3	6	9	12	15	18	21	24	27	30	33	36
4	8	12	16	20	24	28	32	36	40	44	48
5	10	15	20	25	30	35	40	45	50	55	60
6	12	18	24	30	36	42	48	54	60	66	72
7	14	21	28	35	42	49	56	63	70	77	84
8	16	24	32	40	48	56	64	72	80	88	96
9	18	27	36	45	54	63	72	81	90	99	108
10	20	30	40	50	60	70	80	90	100	110	120
11	22	33	44	55	66	77	88	99	110	121	132
12	24	36	48	60	72	84	96	108	120	132	144
13	26	39	52	65	78	91	104	117	130	143	156
14	28	42	56	70	84	98	112	126	140	154	168
15	30	45	60	75	90	105	120	135	150	165	180
16	32	48	64	80	96	112	128	144	160	176	192
17	34	51	68	85	102	119	136	153	170	187	204
18	36	54	72	90	108	126	144	162	180	198	216
19	38	57	76	95	114	133	152	171	190	209	228
20	40	60	80	100	120	140	160	180	200	220	240
21	42	63	84	105	126	147	168	189	210	231	252
22	44	66	88	110	132	154	176	198	220	242	264
23	46	69	92	115	138	161	184	207	230	253	276
24	48	72	96	120	144	168	192	216	240	264	288
25	50	75	100	125	150	175	200	225	250	275	300
26	52	78	104	130	156	182	208	234	260	286	312
27	54	81	108	135	162	189	216	243	270	297	324
28	56	84	112	140	168	196	224	252	280	308	336
29	58	87	116	145	174	203	232	261	290	319	348
30	60	90	120	150	180	210	240	270	300	330	360
31	62	93	124	155	186	217	248	279	310	341	372
32	64	96	128	160	192	224	256	288	320	352	384
33	66	99	132	165	198	231	264	297	330	363	396
34	68	102	136	170	204	238	272	306	340	374	408
35	70	105	140	175	210	245	280	315	350	385	420
36	72	108	144	180	216	252	288	324	360	396	432
37	74	111	148	185	222	259	296	333	370	407	444
38	76	114	152	190	228	266	304	342	380	418	456
39	78	117	156	195	234	273	312	351	390	429	468
40	80	120	160	200	240	280	320	360	400	440	480
41	82	123	164	205	246	287	328	369	410	451	492
42	84	126	168	210	252	294	336	378	420	462	504
43	86	129	172	215	258	301	344	387	430	473	516
44	88	132	176	220	264	308	352	396	440	484	528
45	90	135	180	225	270	315	360	405	450	495	540
46	92	138	184	230	276	322	368	414	460	506	552
47	94	141	188	235	282	329	376	423	470	517	564
48	96	144	192	240	288	336	384	432	480	528	576
49	98	147	196	245	294	343	392	441	490	539	588
50	100	150	200	250	300	350	400	450	500	550	600

1	2	3	4	5	6	7	8	9	10	11	12
51	102	153	204	255	306	357	408	459	510	561	612
52	104	156	208	260	312	364	416	468	520	572	624
53	106	159	212	265	318	371	424	477	530	583	636
54	108	162	216	270	324	378	432	486	540	594	648
55	110	165	220	275	330	385	440	495	550	605	660
56	112	168	224	280	336	392	448	504	560	616	672
57	114	171	228	285	342	399	456	513	570	627	684
58	116	174	232	290	348	406	464	522	580	638	696
59	118	177	236	295	354	413	472	531	590	649	708
60	120	180	240	300	360	420	480	540	600	660	720
61	122	183	244	305	366	427	488	549	610	671	732
62	124	186	248	310	372	434	496	558	620	682	744
63	126	189	252	315	378	441	504	567	630	693	756
64	128	192	256	320	384	448	512	576	640	704	768
65	130	195	260	325	390	455	520	585	650	715	780
66	132	198	264	330	396	462	528	594	660	726	792
67	134	201	268	335	402	469	536	603	670	737	804
68	136	204	272	340	408	476	544	612	680	748	816
69	138	207	276	345	414	483	552	621	690	759	828
70	140	210	280	350	420	490	560	630	700	770	840
71	142	213	284	355	426	497	568	639	710	781	852
72	144	216	288	360	432	504	576	648	720	792	864
73	146	219	292	365	438	511	584	657	730	803	876
74	148	222	296	370	444	518	592	666	740	814	888
75	150	225	300	375	450	525	600	675	750	825	900
76	152	228	304	380	456	532	608	684	760	836	912
77	154	231	308	385	462	539	616	693	770	847	924
78	156	234	312	390	468	546	624	702	780	858	936
79	158	237	316	395	474	553	632	711	790	869	948
80	160	240	320	400	480	560	640	720	800	880	960
81	162	243	324	405	486	567	648	729	810	891	972
82	164	246	328	410	492	574	656	738	820	902	984
83	166	249	332	415	498	581	664	747	830	913	996
84	168	252	336	420	504	588	672	756	840	924	1008
85	170	255	340	425	510	595	680	765	850	935	1020
86	172	258	344	430	516	602	688	774	860	946	1032
87	174	261	348	435	522	609	696	783	870	957	1044
88	176	264	352	440	528	616	704	792	880	968	1056
89	178	267	356	445	534	623	712	801	890	979	1068
90	180	270	360	450	540	630	720	810	900	990	1080
91	182	273	364	455	546	637	728	819	910	1001	1092
92	184	276	368	460	552	644	736	828	920	1012	1104
93	186	279	372	465	558	651	744	837	930	1023	1116
94	188	282	376	470	564	658	752	846	940	1034	1128
95	190	285	380	475	570	665	760	855	950	1045	1140
96	192	288	384	480	576	672	768	864	960	1056	1152
97	194	291	388	485	582	679	776	873	970	1067	1164
98	196	294	392	490	588	686	784	882	980	1078	1176
99	198	297	396	495	594	693	792	891	990	1089	1188
100	200	300	400	500	600	700	800	900	1000	1100	1200



SAWYER SPINDLE.

OUR STYLES OF SPINDLES.

"If an improvement is found it will probably be discovered by those whose education in this line has been most complete."—Textile Texts, 1903 edition.

We are now entering the third era in the history of our spindle business; or rather, that of the Sawyer Spindle Company as handled by our Company as sole agents. The Sawyer spindle period marked the first era, a period which saw the absolute overthrow of the early, common type, and an exciting battle for favor between the Sawyer, the Pearl, and the early Rabbeth type. The litigation of this period was continuous, expensive and picturesque. The final triumph of the Sawyer marked the opening of a second era, as its success stimulated experiments in an entirely different line.

This second era was introduced by the advent of the self-centering, or top spindle, of Rabbeth, associated from its start with the contemporary inventions of Sherman, Taft & Woodmancy, Atwood and others. These types, as improved by various other inventors, also stimulated competition, with the necessary litigation, in which the Chapman, (or Eureka), the Buttrick and Flanders spindles and others were held to infringe. The Atwood silk spindle, made under agreements with the Sawyer Spindle Company, also had a record of continuous and successful litigation with competing silk structures.

The principle involved in the Rabbeth yielding bolster idea has been copied and adopted throughout the cotton manufacturing world. Foreign countries have had free use of its great advantages, as it was not fully protected by patents outside the United States. The expiration of the Rabbeth patent did not, however, induce immediate imitation in this country, for the principles involved in its successful trade design were covered by later patents.

The third era is now introduced by the expiration of such patents as cover usable structures of the high speed type. It is peculiarly fitting that with this expiration we should be ready with a new and superior device with which to continue an unbroken line of trade control. It is also peculiarly fitting that this important new improvement, which we shall describe at length, is the invention of the same Rabbeth who was well known to the trade as an important inventor, even before the Sawyer Spindle was designed. It has been known for years that the spinning frame spindle was far ahead of the rest of the frame in development, as it would run successfully at a higher speed than was practical for the associating mechanisms. While carrying its load, or bobbin, however, at such high

speeds, there was always a fault in the driving connection between the spindle and the bobbin, resulting in bobbins standing at different levels on the spindles, fitting with different degrees of tightness, limiting the length of traverse, and making considerable bad yarn. The Rabbeth patent centrifugal clutch enables these difficulties to be practically overcome without the introduction of other troubles, allowing stronger bobbins and much greater variation in the dimensions of the fitting portion.

Those now marketing slavish copies of the spindles which we sold to the trade some 17 years ago, are of necessity withheld from profiting by the ideas devised and patented within that period. Such copies are naturally offered at a low price; but we ourselves can furnish low priced spindles to those who wish for them, and those who purchase from us will naturally have the advantage of knowing that they are buying from the most experienced builders of this class of machinery, with a reputation for excellence in product which they are hardly ready to relinquish. The art of making spindles is not learned in months, or even years, if the experience be limited to a small variety or a small product. It is, of course, possible to reproduce any mechanical product so that the eye may be deceived by appearance, but **spindles are products made with a fineness not visible to the unaided eye.** We have not only discovered certain methods which ensure accuracy in product, but we have protected the same by patents and others cannot use them. We have had the long experience necessary to learn the niceties of spindle manufacture, and we also know how many chances there are by which expense can be curtailed by those who may not adopt our methods of manufacture, our rigid gauging and inspection, and our careful selection of stock. We intend to continue making the best spindles in the market. If they embody new inventions in design, we shall ask a higher price than if they are copies of old, unprotected designs. If the trade demands the ancient styles, we shall still try to make them better than our competitors.

The merit of a spindle is not shown by visual inspection, neither is it necessarily shown by the action of the spindle in its first trial. A spindle may seem to run well and yet be consuming an excess of power. It may run well at first, but be wearing out rapidly. It is time for new builders to tell of the merits of their spindles when theirs have been run for twenty to thirty years, like some of our own.

The lapse of the patents controlling the fundamental principle of high speed has ended for a time the prosperity of the prolific spindle inventor. During the second era, formerly referred to, we thought it advisable to establish our control by

purchasing nearly all the novelties in spindle construction that were brought to our attention when the price was not excessive. These inventions not only covered many variations in the detail of the trade spindles in use, but they also included spindles with ball and roller bearings, compound spindles, dead spindles, spindles to run without oil and without bands, spindles to run with less power, and spindles that would not run at all.

A spinning-frame spindle of the trade type is simply a revolving shaft to carry a bobbin at high speed. The normal tendency of this shaft, under the influence of the band, would be to rotate in a position determined by the confines of its bearing, were it perfectly true, straight, round and uniform in quality, were its load ever the same, were it absolutely central in its ring, and were the side pull of the yarn also uniform during its revolution. Such conditions are, of course, impractical and impossible. The centre of gravity of the spindle and its load in practice is not coincident with the geometric centre. The centrifugal force of the offset centre of gravity naturally tends to cause the spindle to gyrate or wobble, producing so much vibration in the old, common type of spindle, as to limit its practical range of speed. The Pearl spindle sought to overcome this vibration by reducing the weight and thereby reducing the amount of the centrifugal force developed. The Sawyer spindle also reduced weight and carried a steadying bearing up within the load. The Rabbeth top spindle introduced a yielding bearing, which allowed the spindle to move slightly with its bearing, in obedience to the centrifugal force, the result being that the vibration was so transferred and reduced that the actual movement of the load itself under ordinary conditions was almost imperceptible; in fact, the loose bearing principle allows a spindle to carry an uneven load and still run with apparent smoothness.

While a modern spindle can accommodate a certain amount of unbalance, it does so at the expense of extra consumption of power and wear. It is therefore important that it should be made well, designed well and used well. The best spindle now on the market is the **"Draper"** in its improved and modernized form. The most important recent improvement, is known as the **Rabbeth centrifugal bobbin clutch.** This device consists of loose bearing segments above the whorl, which fit loosely within the bobbin when the spindle is at rest. The motion of the spindle, however, throws these segments by centrifugal force, against the interior of the bobbin, giving sufficient driving power to prevent any slip under modern conditions of speed. There is, of course, no limit to the high speed at which the device is prac-

tical, for it grips harder as the speed increases. One great advantage of this clutch drive is that there is no reason why all bobbins should not come down to a common level. This enables the traverse to accommodate such a level, and in many cases allows at least one-half of an inch more of yarn traverse on the bobbin. **There is less slack yarn and less waste yarn.** There is no tendency whatever to split bobbins, and the bore for the bobbin is of less diameter than with the friction drive, allowing it to be made stronger. All bobbins shrink and swell more or less, especially those used for filling; but the clutch allows so loose a fit as to give much larger leeway in the dimension of the bobbin bore before reaming is necessary. We have thousands of these spindles running, and from our present experience and observation we believe the merits of the idea will be universally recognized. A longer traverse means less frequent doffing, less work at the spooler with warp yarn, and less knots in the warp. With filling yarn it means less frequent changing of shuttles on common looms, less bobbins to place in the hoppers on Northrop looms and less defects in the cloth from changes of filling with either style of loom.

As the bobbin fits loosely with the spindle at rest, the labor of doffing is considerably lessened. There is, therefore, less tendency to bend the spindle blade, an evil almost always due to tight bobbin fits. The life of bobbins used with the clutch should be considerably lengthened.

In order to anticipate the usual waste of imitative effort, we may say that we already have some 40 patents covering modifications and variations of this general clutch principle, including the use of rolls, balls, friction clutches, spring clutches, pivoted clutches, etc. Spindles with Rabbeth clutches can be obtained in frames from any licensee of the Sawyer Spindle Company, and will be furnished both for new and old frames by ourselves. We will also sell blades and whorls equipped with this clutch for use in old bolsters and bases. **We cannot apply the new whorl with centrifugal clutch to old blades.**

While we show several illustrations of our popular models, we do not attempt to illustrate all the known modifications. There are so many different styles of blades and bases that the combinations are almost endless. The blades are of different designs and different lengths. The whorls are made with different cups, with no cup at all, and with the centrifugal clutch. The bases are made with the old style snout, with brass oil-cap and steel retaining-hook; also in the Draper No. 2 style of Woodmancy base, and also in the recent Model E base. The Model E base is in two patterns, one with round seat, the other with a double slabbed seat to avoid lifting rods.

MODEL E BASE.

Double slabbed pattern, viewed from above.

Many customers prefer to have all of their spindles of this double slabbed pattern, although they are not so easily levelled by papering under the rim. The Model E is more convenient for oiling, being made under patent of C. E. Lovejoy. It gives extra freedom for band knots to pass and is strengthened at former weak sections. The doffer guards will not break so easily as on the old base; in fact, they will not break at all now with any decent treatment. The bases for the centrifugal clutch spindle vary from the regular standard, since with the centrifugal clutch the bolster is set lower in the base, and the base is less in height. On account of the variations in patterns, care must be taken in ordering, to specify accurately just what is wanted, and if spindles are to duplicate old lots, it is necessary to send a sample with the order.

We make a specialty of furnishing repair parts for all styles of spindle, whether originating in our works or not. As we have special tools for assembling it is best to let us do as much of the assembling as possible. We also make special spindles for special uses, working to drawings or samples.

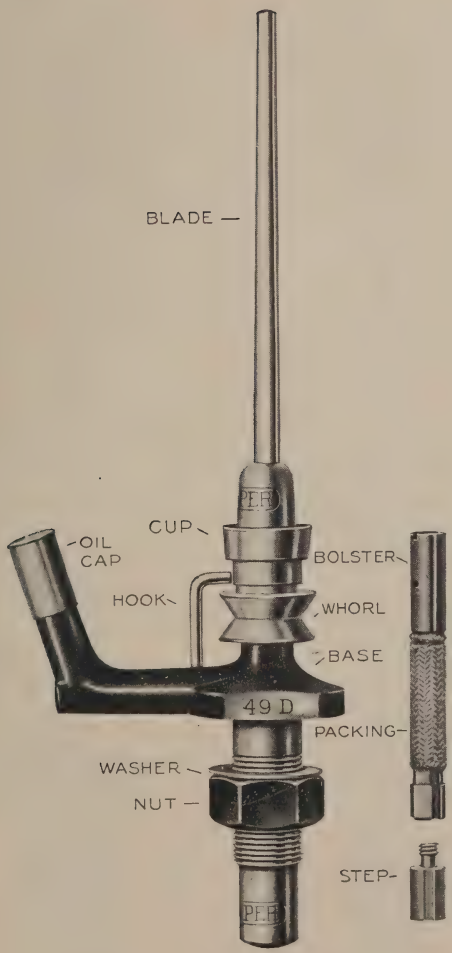
49 D SPINDLE.

The parts of the 49 D spindle, as illustrated, are not wholly sub-divided, since we do not sub-divide them in repairs; for instance, we prefer to sell the spindle blade with the whorl and cup attached, for these parts must be assembled on special machinery in order to have them concentric. The blade, as shown, is really in four parts, as it has blade, whorl, cup and also a brass collar forced on under the whorl, to prevent the rising of oil. The blade of the old 49 D spindle differs somewhat in section from that of the Draper, and we recommend our customers to order the regular Draper blade, as it will fit in the 49 D bolster and is of stronger section. Note that blades are made in two regular lengths, and with two styles of top; that is, the longer traverse blade has a cylindrical top, and the shorter traverse blade has a tapering top. The short traverse blade is shown in the illustration. The cups are also made in two general styles, one for warp bobbins and one for filling bobbins, the filling bobbins usually taking a larger cup. The small cup is shown in the illustration.

The whorls are also made in varying styles, being usually either 3-4 or 13-16, or 7-8 in diameter at the band groove. The 3-4 whorl is shown in the illustration. Since the taper on the whorls of the spindles made by different shops varies slightly, this also introduces a variation which necessitates accurate knowledge of the style to be duplicated.

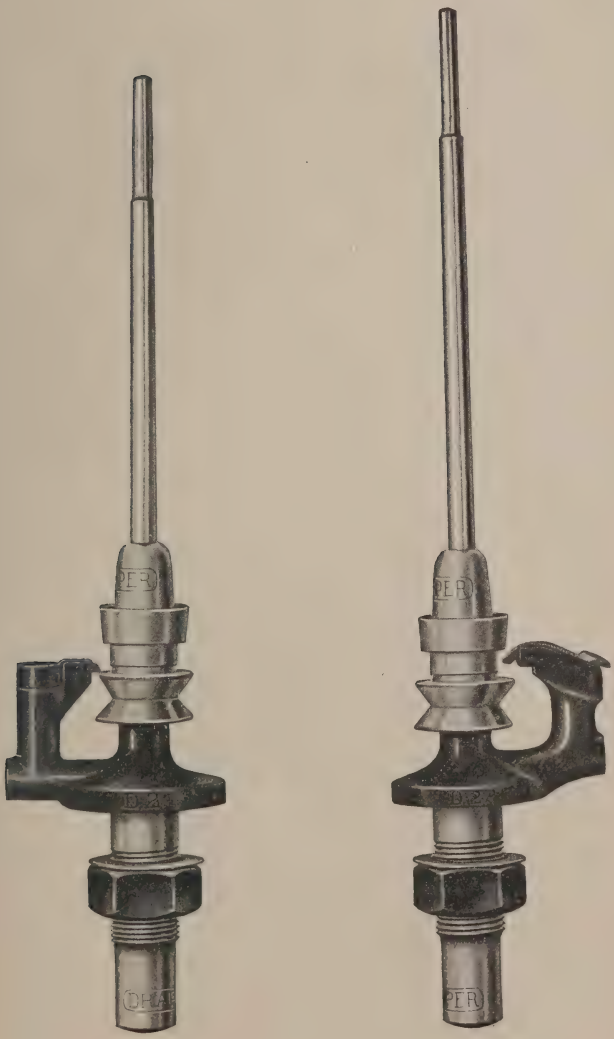
The 49 D base is usually supplied with the hook, although we sell the hooks separately; also the brass oil caps. Bases are always supplied with their retaining pins in place. Nuts and washers are furnished separately and in quantities desired. The bolster is usually supplied with the wicking and strings attached, though we can furnish wicking in quantity desired. Steps sometimes wear sufficiently to need replacement, although they are carefully hardened. We furnish 49 D bolsters and steps in Draper or Model E bases, if requested.

Note that our spindle whorls and bases are now all marked with the word "DRAPER" enclosed in a round-cornered rectangle. This mark signifies that the piece so marked is made by Draper Co. It is not a name for the spindle as we use the same mark on Whitin and other spindles of our own manufacture.


BLADE
CUP
OIL CAP
HOOK
BOLSTER
WHORL
BASE
49 D
PACKING
WASHER
NUT
STEP
PF.E
PF.E

STYLES IN BASES.

In the illustrations on the opposite page may be noticed the earlier form of Woodmancy dofter guard in Draper No. 2 base at left, and the round Model E base at right.



DRAPER SPINDLE.

The Draper spindle differs from the 49 D in the following particulars:

The blade is of a different design, giving greater stiffness and strength. The illustration shows the long traverse.

The base has the Woodmancy doffer guard and oil cover. The illustration shows the round Model E style.

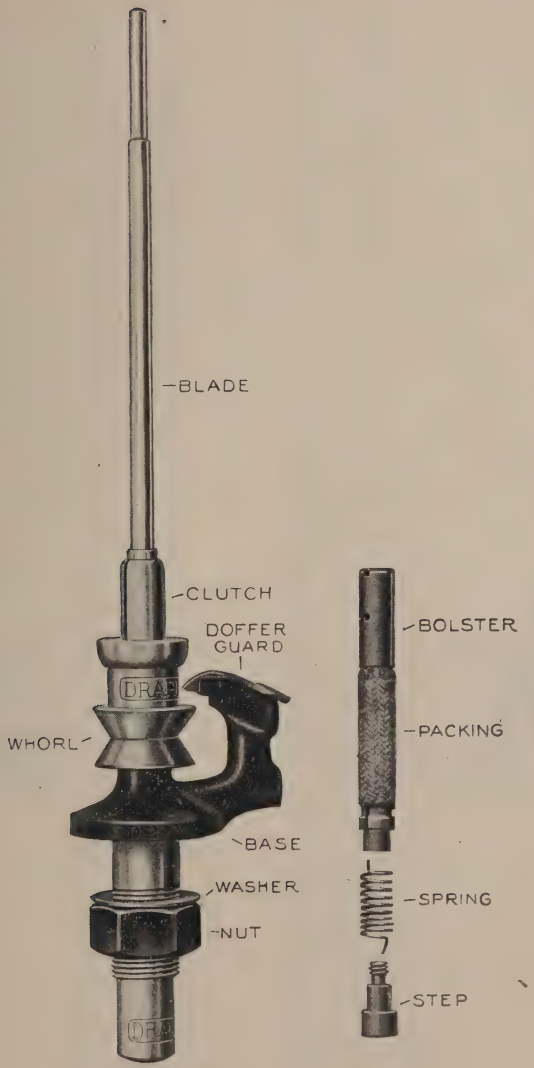
The bolster and step are united by a spring, the step alone being held by a single pin in the base. The spring lock between the bolster and step allows them to be removed and carefully adjusted by hand without chance for change of position when replacing in the base.

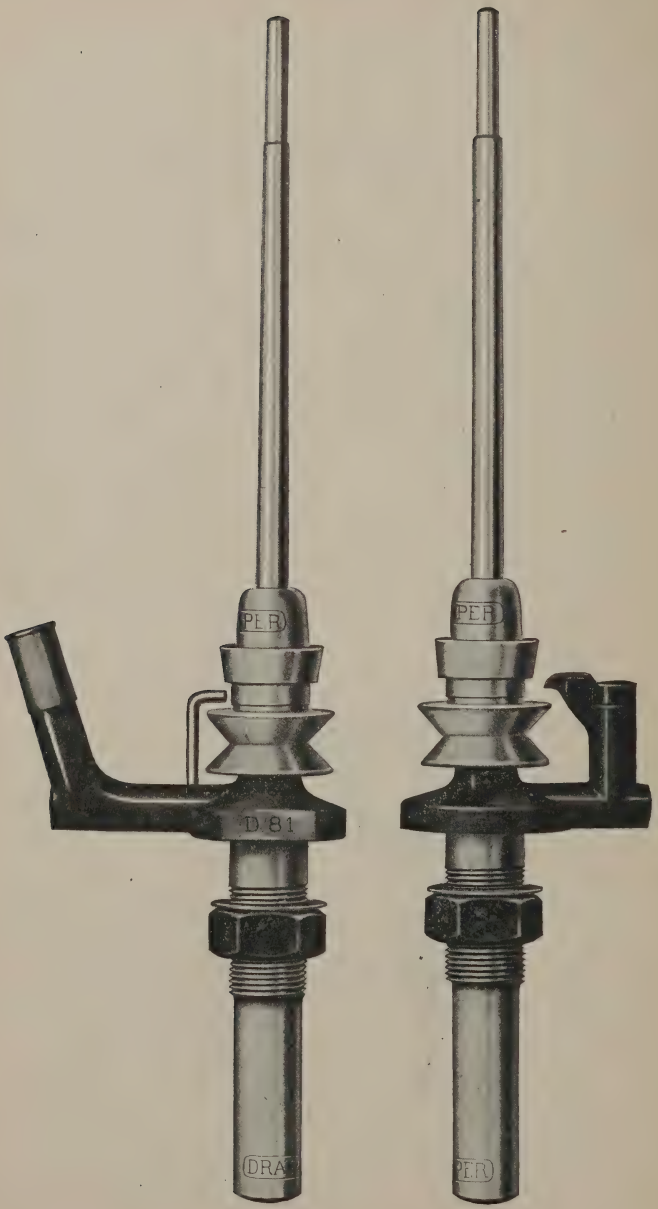
The Rabbeth centrifugal bobbin clutch is seen on this model. When the clutch is used the base is slightly different than when the ordinary friction seat is applied since the bolster is necessarily lowered and the base top shortened.

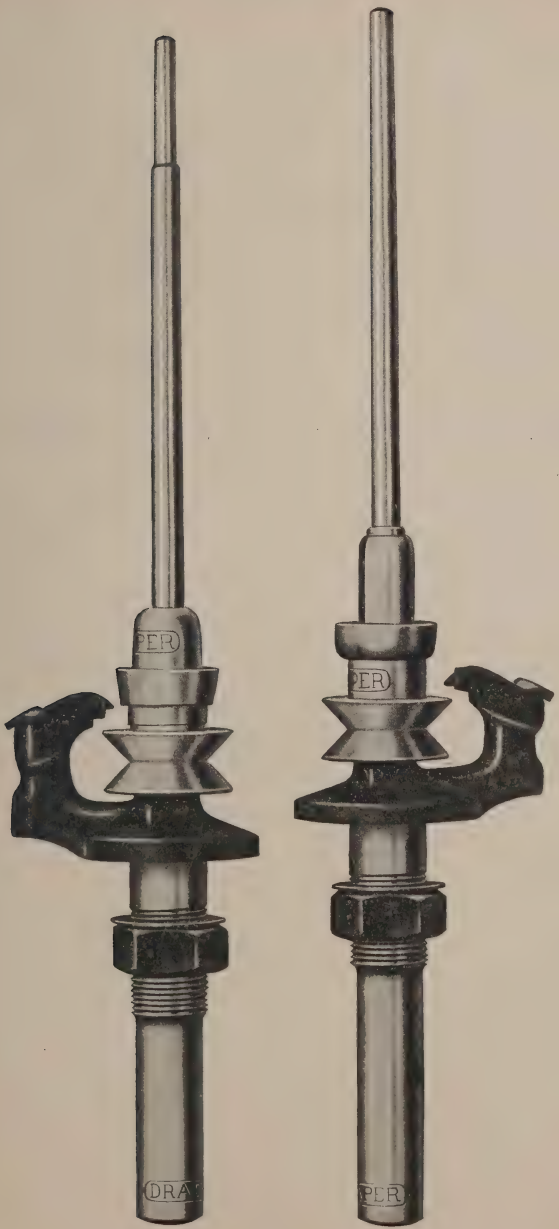
LARGE SIZES.

On pages 158 and 159 are seen the larger sizes of spinning spindles of various forms. They are in order as follows:

1 D 81 which is a large size 49 D.
2 D No. 4 which is a large size Draper No. 2.
3 Large Draper in round Model E base.
4 Large Draper Rabbeth Clutch type in round Model E base.


BLADE
CLUTCH
DOFFER GUARD
WHORL
BASE
WASHER
NUT
BOLSTER
PACKING
SPRING
STEP

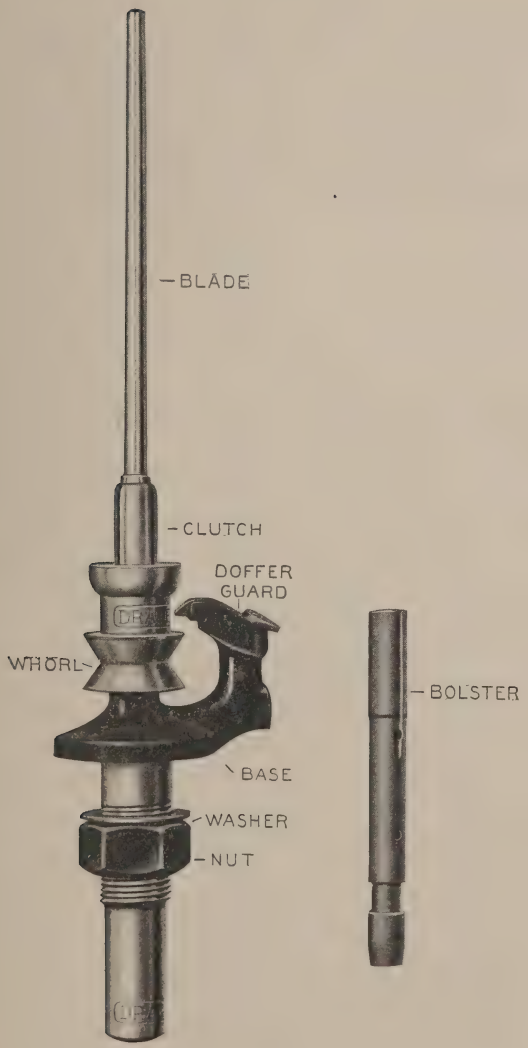

PER
D 81
DRA
PER
PER


PER
PER
DRA
PER

WHITIN (OR GRAVITY) SPINDLE.

As is probably well known, we have complete equipment for manufacture of other spindles controlled by the Sawyer Spindle Company. The Whitin is one of the well known types which is largely ordered. It has the Woodmancy Doffer Guard and upright oil tube and the general dimensions are similar to those of the Draper. Its main points of difference are in the bobbin seat, which is usually made without the cup, the bearing, which is in one piece and cylindrical in bore, and in the absence of cushion and means for adjustment.

The illustration on next page shows our Whitin spindle with Rabbeth clutch in round Model E base. We also furnish it with or without Rabbeth clutch in regular base.


BLADE
CLUTCH
DOFFER GUARD
WHORL
BOLSTER
BASE
WASHER
NUT

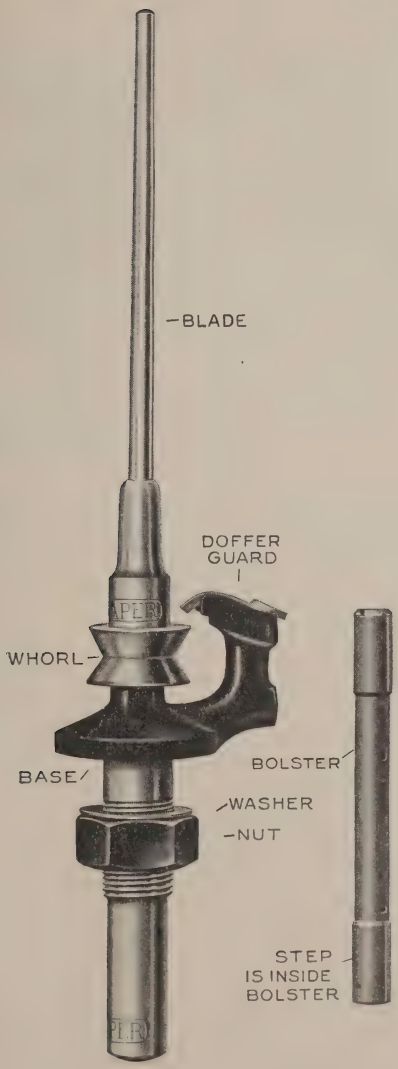
MCMULLAN (OR SACO-PETTEE SPINDLE.)

On page 163 is shown our McMullan spindle in round Model E base. We can furnish it with Rabbeth clutch when desired. The McMullan spindle is made by us to duplicate those furnished by the Saco and Pettee Machine Shops and we can furnish any style of base that they use.

SPINDLE MANUFACTURE.

When an art becomes fairly standardized, progressive manufacturers devote their attention to the perfection of the processes of manufacture. We have evolved nearly as many patented methods of manufacturing spindles as there are principles contained in the invention of the spindle itself. We naturally do not care to explain the detail of processes which are not patented, but we refer briefly to the general details because we wish our customers to understand why we claim superiority in product, and why we emphasize the advisability of patronizing our own product, although the spindles which we make are duplicated by other builders.

Starting with the raw material, we use a long tried mixture of iron in order to have castings that can be cleanly cut. Our annealing process was discovered in our own works and patented. The spindle blades are made from the best known grade of steel and forged under heat of a constant temperature. We have patented machinery for grinding the blades as we found the ordinary processes did not ensure perfect work. A spindle that is not concentric will vibrate and wear even though the extent of vibration is not easily noticed. All of our spindle parts are closely gauged and carefully inspected. We have special tools to true the whorl on the spindle and to aid in the assembling. The bases are all tested for air holes, and each spindle is tested at a speed of 12,000 turns per minute before it is sent to the customer. We pack the spindles in a special form of rack and box to protect them from harmful jar during shipment. We are the largest builders of spindles in this country, and we spare no pains to perfect their quality.


BLADE
DOFFER GUARD
WHORL
BASE
BOLSTER
WASHER
NUT
STEP IS INSIDE BOLSTER

SPINNING FILLING ON RING FRAMES.

The greatly increased use of frame filling in the past decade, undoubtedly received its first impulse from the introduction of the evener by the late George Draper. While many frames are now built for filling without the evener attachment, it is doubtful if manufacturers would ever have appreciated the gain in spinning filling on ring frames if it had not been for the persistent efforts made during the introduction of the evener. We have faith in this device, and recommend it wherever our recommendation is appreciated. Comparative tests have proved that yarn could be spun with less twist and less breakages, when this invention is used. Manufacturers have, however, found that filling can be spun on frames without the evener, and many do not care to pay the additional cost. In one way, this makes no difference to us, as we have never taken royalty for the evener, and have no chance for profit in its introduction, except as it may cause more filling spindles to be used. We do not mean to say that filling was never spun on ring frames before the introduction of the evener. Certain hard-twisted coarse filling had been successfully made, but no one attempted to spin slack-twisted filling of the finer numbers. We think that experience has now proved that filling as fine as 80s, and all numbers up to 80s, can be spun on frames to better advantage than on mules, all things considered. With the evener, filling yarn can be spun as slack as it need be for any purpose; it can also be wound harder on the bobbin, as a heavier traveller can be used with the evener than without it. The advantages of bobbin filling are less waste in weaving, less breakage of the filling in weaving out of the shuttle, less cost per pound for labor, less floor space necessary for machinery. There is also one less department in the mill, one less overseer, and a class of help is dispensed with that mill management has always found troublesome.

OLD FRAMES.

We have controlled the introduction of high speed spindles in old spinning frames ever since the Sawyer spindle won its earlier victories. We keep a large force of men constantly engaged in revamping old frames and often making them as good as new at small comparative expense. We are always willing to figure on changes, and in view of the surprising results that are often possible it seems strange, indeed, that any of the earlier types of spindles are still allowed to run. Increase of speed not only increases production, but it may be had without increase of power by the improved models, and labor cost is less per product. We have said so much on this score in the past that it ought not to be necessary to repeat now that ninety-five per cent. of the mills, at least, are converted to our doctrine.

After running so long as feasible in the old frames, new spindles, which we have supplied, can be transferred to new frames, so their purchase for use in old frames involves no chance of loss whatever.

SPECIFICATIONS FOR CHANGING SPINNING.

Name of Company.....Date.....

No. of Frames.....of.....Spindles each..... { Warp..... / Filling.....

Builder.....Gauge.....

Change from..... Spindle to.....

Shall we lower Rails?.....

Shall we raise Cylinder?.....

Shall we lengthen Traverse?.....

Shall we furnish new Builder Motion?.....

What is Traverse now?.....What is wanted?.....

Shall we raise Wire Boards?.....

Shall we put in New Wire Board Knees?.....

Shall we put in new Lifting Rods?.....

Shall we put in new Lifting Rod Bushings?.....

Shall we furnish Separators..... { Rhoades ?..... / Doyle ?.....

Shall we furnish Rings ?.....Diam.....Holder.....

Shall we repair Rolls ?.....

Shall we furnish new Cylinders ?.....

Shall we apply Work and Rings ?.....Separators?.....

In going to Mill to measure frames, for whom shall our man ask to obtain proper information?.....

Orders taken by.....

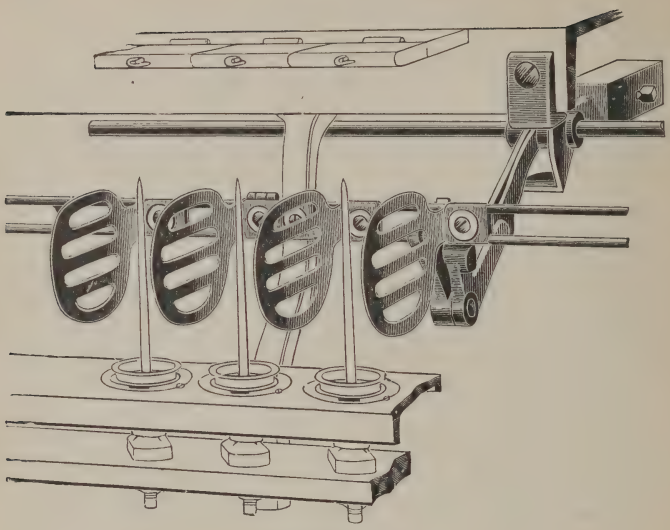


FIGURE 1.

SPINNING FRAME SEPARATORS.

We were the earliest introducers of spinning-frame separators to any extent, and we continue to be the largest manufacturers. The Doyle type was our standard for years, and we still sell it in moderate quantities. The Rhoades-Chandler construction has practically superseded all the narrow-blade styles and it has several imitations supplied by other builders. We believe that our pattern is the best known for general uses and we not only have a large trade in the changing over of old frames, but supply them to builders of new frames.

A separator comes under the head of necessary evils, for it has certain necessary disadvantages. For economical spinning at high speed, a separating device must be used to prevent the conflict of yarn on adjacent spindles unless the gauge of the frame is greater than necessary for the rings used. The Rhoades-Chandler separator can be turned either up or down for doffing, although the downturn is usually preferable. The cuts show the position the blades occupy with the rail at the lower part of the traverse, Fig. 1 showing the separators in normal position with the bobbins removed from the spindle, Fig. 2 the blades turned down, and Fig. 3 the blades turned up. In Fig. 2 it will be noticed that one separator blade contacts with the samson of the frame. Such blades are provided with a special hinge.

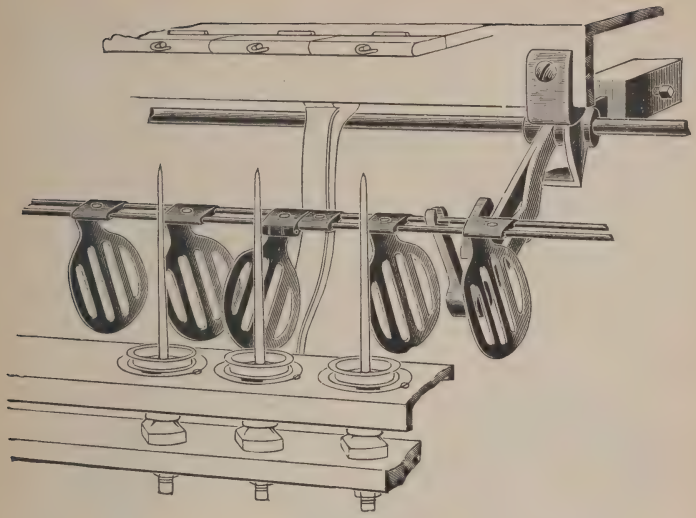


FIGURE 2.

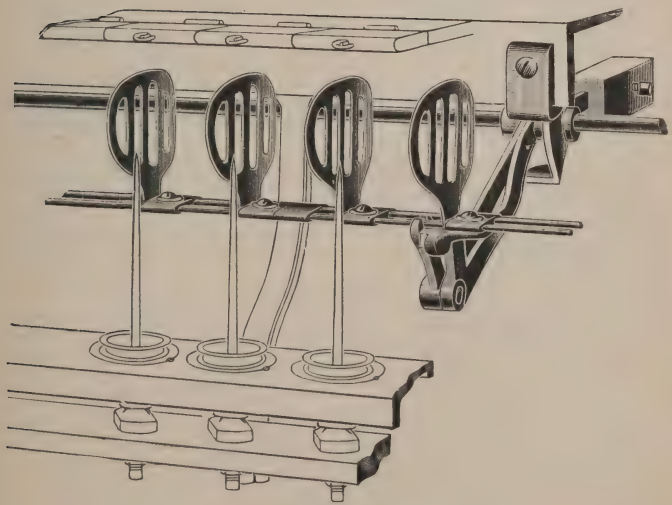
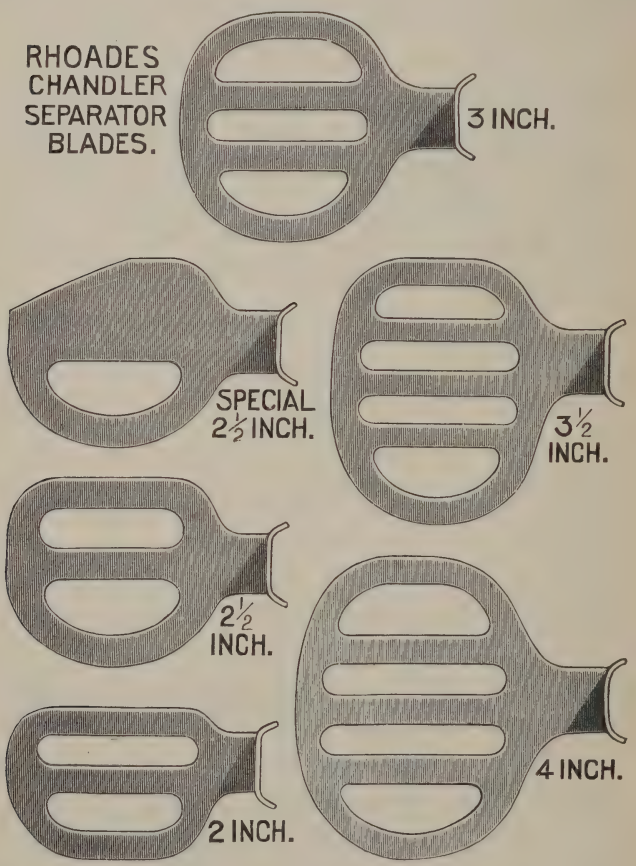
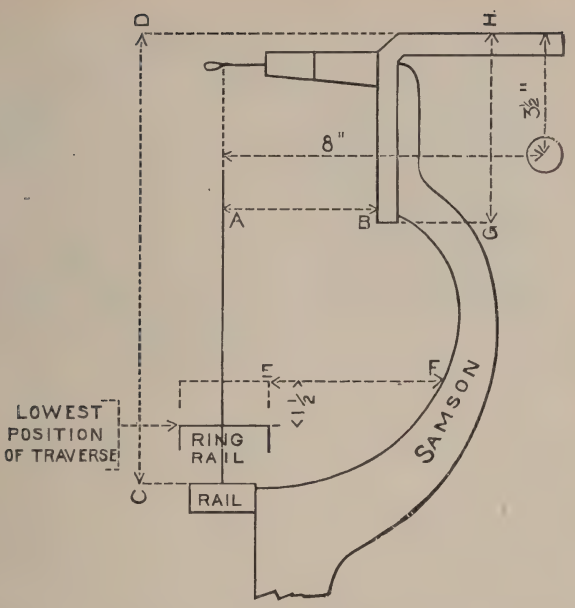


FIGURE 3.

The question of the proper size of blade is of great importance. We can meet any conditions by using different patterns, a few of which are shown.



These blades as shown in the cut are reduced in size.



SPECIFICATION FOR RHOADES-CHANDLER SEPARATORS.

ORDERED FROM DRAPER COMPANY, HOPEDALE, MASS.

Date,.....190.....

Name of company?.....

Builder of frames?.....

Number of frames?.....

Number of spindles in each frame?.....

Gauge of frame?.....

Total length between end spindles?.....

Length of traverse on bobbin?.....

Width of ring rail?.....

Distance top of roller beam to top of bolster rail C to D?

Distance face of roller beam to center of spindle, A to B?

Distance under side of guide board to bottom of roller beam?.....

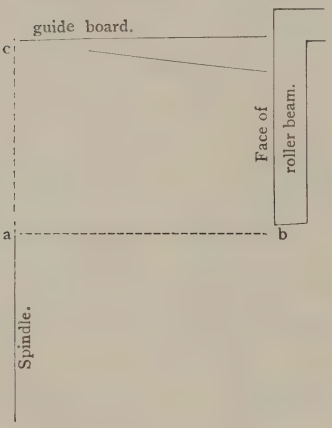
Width of face of roller beam, G to H?.....

Is there a place to run a rod the length of frame, 8 inches back of spindle and 3½ inches from top of roller beam?.....

If not state what is the nearest position such a rod may be placed in?.....

Width of wire board back?.....

Width of wire board drops?.....
Ship via?.....
Blank specification sent on application.....

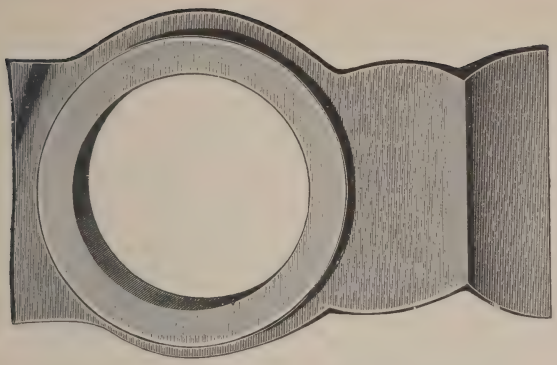


SPECIFICATIONS FOR DOYLE SEPARATORS.

ORDERED FROM DRAPER CO., HOPEDALE, MASS.

Date.....190.....

Name of company?.....
Number of frames?.....
Number of spindles in each frame?.....
Builder of frame?.....
Gauge of frame?.....
Distance from center of end spindles?.....
Length of traverse on bobbin?
Width of ring rail.....
Distance from face of roller beam to center of spindle? a to b
Distance from top of roller beam to top of bolster rail?.....
Distance from under side of guide board to bottom of roller beam
Width face of roller beam?.....
Width wire board back?.....
Width wire board drops?.....
Ship via.....
Remarks.....



FORGED RING IN BAR WITH CENTRE PUNCHED OUT.

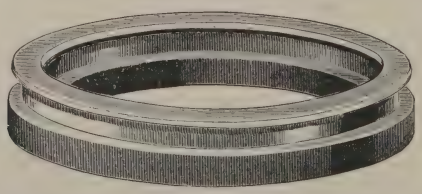
SPINNING RINGS.

The double flange spinning-ring has become a standard trade article supplied by several builders. We were its only manufacturers from 1869 to 1886, and averaged a product of over 400,000 rings per year for the last ten years of this period. Even with the present competition we sell a much higher average to-day, reaching a product of 1,520,722 in the year 1900. Our total sales figure over 20,000,000 rings. No other manufacturer has made as many rings of any nature, and no other manufacturer has had but a fraction of our experience in the manufacture of the double ring. The single ring has almost disappeared as an element of competition. It held favor for some time after the double ring was introduced, with certain manufacturers, because it was not so hard as the double ring and therefore wore out less travellers in starting up. It naturally wore out much quicker than either flange of the double ring, and at the present price of the double ring it has no market standing. Attempts have been made at times to introduce single rings of stamped stock. We, ourselves, purchased the business of a competitor in this line and prepared to supply

FORGED RING BLANK.

customers, but we found that stamped rings are inferior of necessity, since the stock that can be stamped cannot be properly and uniformly hardened.

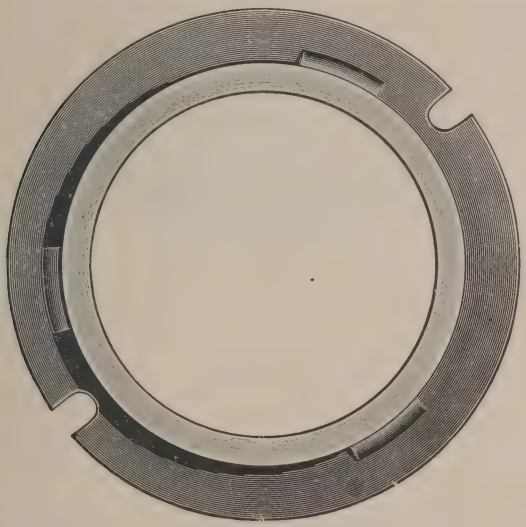
While several manufacturers sell double flange rings, the products are not similar. **We control patented processes of manufacture which make our ring distinct and superior.** We not only control the only known method of producing a practically round spinning ring, but we have recently introduced a new method of polishing the surface on which the traveller bears, so that our rings start like old rings, greatly reducing the trouble and annoyance when new rings are applied. Every spinner in the country can appreciate what this means. We drop-forge our own ring blanks from the rough, bar stock, and therefore know the quality of the forgings used. The rings are turned on special heavy lathes built for that purpose, and we have of late adopted a policy of double turning by which we produce greater accuracy in size and a smoother cut surface. The rings are hardened in furnaces supplied with the very latest improvements for maintaining regular heat. They are then put through our patent rounding process, which also gives them a second tempering. The rings are then polished and inspected, every ring being tried with a file for hardness, tested for roundness and examined for polish. We also test rings at various points in the manufacture, breaking a considerable fraction to note the internal structure which exposes the degree of temper and the granular construction. We believe our inspection to be closer than that of other manufacturers, for we have passed their rings through our inspecting force and found them not up to our accepted standards. We make all sorts of rings desired in common trade practice; spinning rings of all sizes whether single or double and with different sizes of flange; twister rings, both flat and vertical; ring-holders, ring screws, traveller clearers, etc. We probably carry a larger stock of rings on hand than any other manufacturer.



RING BLANK AFTER ONE-HALF THE RING IS TURNED.

Our rounding process has exceeded our expectations. There is no such thing as perfection, however, so that while all our rings are round, some of them approach perfection more

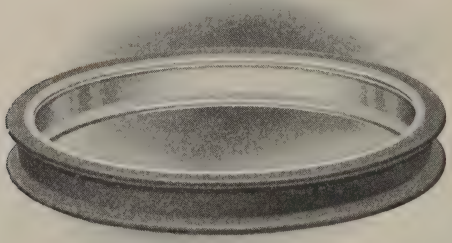
nearly than others. All of them are better than a ring made without the rounding process. We select the very best for our most critical customers at an extra charge. During this rounding process the ring is heated cherry red and forced into a die of circular section. It is cooled while in the die and therefore the strains which tend to make it elliptical are counteracted by the resistance of the die.



ROUND RING IN THREE-EARED HOLDER.

We have undertaken to improve our polishing process for a long period of years. We took up the burnishing process when that was attracting attention and have always been ready to furnish burnished rings to our customers at an extra price, in view of the extra expense. In our hand polishing we have increased expense by insisting on a longer application of the polishing stick, but it was only recently that **we discovered a method by which the polishing process could be extended over hours instead of minutes without heating the ring.** With this process the rings receive an inside polish smoother than any other finish we have known. The rings naturally start easier when so finished. Although the process requires additional machinery and a longer process of application, we have decided not to raise the price of our ring, not even adding the usual extra two cents which we charge for the burnishing process. We have tried out these rings thoroughly with some of our best customers, and their repeat orders so swamped us with work that we could not keep

up with the demand. Our advertising department prepared a circular in January, 1906, which was never sent out, but revised and issued many months later, because we could not make the necessary machinery fast enough to anticipate the demand.

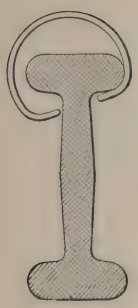


THOMPSON PATENT MIRROR FINISH RING,
Before receiving outer polish.

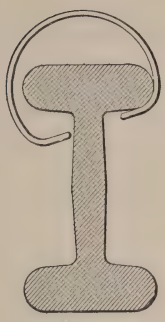
SPINNING RING FLANGES.

It has been customary ever since ring spinning was first introduced, to use the standard size of flange for all classes of spinning, whether the ring were 1 1-4 inches in diameter, or 2 1-4 inches. This system worked very well so long as ring spinning was confined to coarse and medium numbers of yarn, but with the introduction of finer ring-spun yarn, it has been found advisable to reduce the size of the flange so that the traveller can also be reduced in circle, and therefore allow a larger wire without increasing the weight. A small circle traveller cannot well be used on the ordinary sized flange, as it will not stretch over without breaking. We have been selling the small flange ring for years, our sales having increased rapidly within the last year or two, several hundred thousand being sent out within the last two years alone. We recommend it only for rings 1 5-8 inside diameter and less.

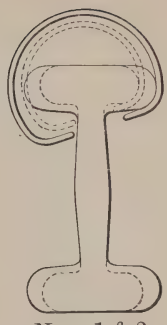
SIDE VIEW OF TWO-INCH RING.



No. 1



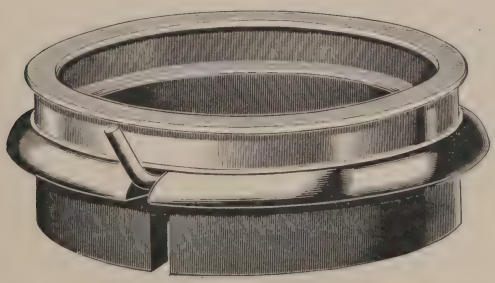
No. 2



Nos. 1 & 2

The cuts are self-explanatory. The No. 1 flange is shown in an enlarged section, being the new, small size to which we are referring. The No. 2 flange is the regular ring section, and the third illustration shows one drawn over the other, so as to give absolute comparison of sizes. We sell the No. 1 flange ring at our regular price, and it is, of course, up to our regular standard in quality.

Many users of rings do not understand why those produced to-day do not wear so well as those we supplied years ago. The explanation is simple. The rings of today are used with travellers running at much higher speed, and the travellers are also lighter. Curiously enough, the lighter travellers wear the rings much faster than heavy travellers. The increase in size of ring has also increased the relative speed of the traveller on the ring. The high speed of traveller not only produces direct wearing action, but it also heats the ring and draws its temper.



DOUBLE RING IN CAST IRON HOLDER WITH WIRE TRAVELER CLEARER.

PRICE OF DOUBLE-ADJUSTABLE RINGS.

With Either Cast-Iron or Plate-Holder.

DIAMETER IN INCHES.	PRICE	
	With either Holder.	Without Holder.
1	14 cents.	10 cents.
1 1-16	14 "	10 "
1 1-8	14 "	10 "
1 1-4	14 "	10 "
1 3-8	14 "	10 "
1 1-2	14 "	10 "
1 9-16	14 "	10 "
1 5-8	14 "	10 "
1 11-16	15 "	11 "
1 3-4	16 "	12 "
1 13-16	17 "	13 "
1 7-8	18 "	14 "
1 15-16	19 "	15 "
2	20 "	16 "
2 1-8	22 "	18 "
2 1-4	24 "	20 "

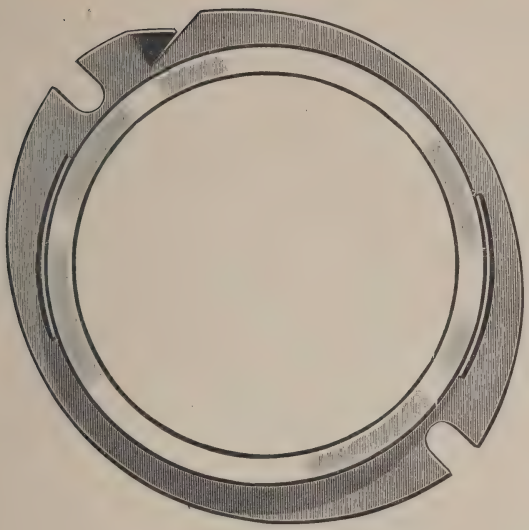
In lots of 5000 or more taken in any one year, a discount of 10 per cent. will be allowed from the above prices after 5000 have been delivered.

For guaranteed round rings, add two cents.

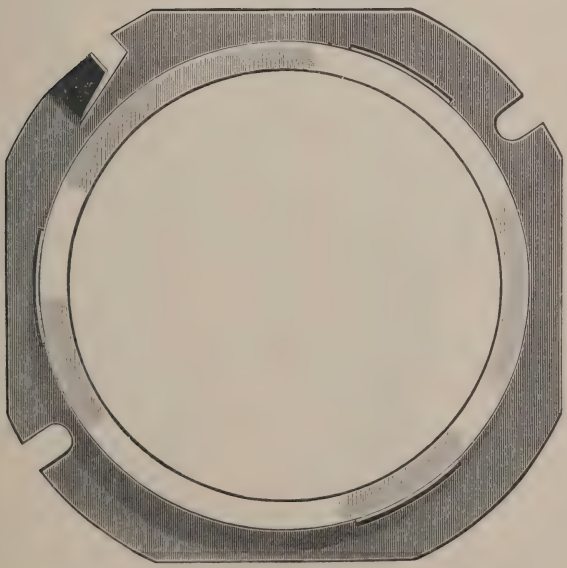
For burnished rings, add two cents.

Traveller cleaners free when ordered of the type shown with plate-holders. This is the best one known, presenting no complication of parts, and is always in proper position.

Competent men sent to apply our rings, at cost of time and expenses.



Oval holder for 2 Inch Ring.



Square Holder For 2 1-4 Inch Ring.

SHAW & FLINN'S PATENT LIFTING ROD CLEANER.

This simple and practical invention, which is shown in cut on opposite side, full size for three-quarter inch lifting rod, is the result of a necessity for something that will prevent the frequent stopping of lifting rods and the ring rails they carry.

Everyone familiar with the details of spinning cotton yarn knows that dirt and lint will adhere to the lifting rods and be carried into the bushings or guides set in the frames for the rods to work in; this accumulation of dirt will wear the rods, and sooner or later is liable to stop one or more on a frame.

This attachment is made of wire, covered where it passes round the lifting rod with a twisted and braided cord, which fits the rod closely, but not tight enough to cause undue friction; the elasticity of the wire and its covering prevents any liability of the rod sticking on account of collection of dirt. The two parts or covered rings are formed at the ends of one piece of wire, which is bent to pass over the back side of the rail holding the bushing through which the rods run. In forming the cleaner, sufficient spring is given to the wire to cause the rings to fit closely to the top and bottom of the bushing.

The lifting rod cleaner has been in use for years, giving satisfaction, and those who use it extensively consider it a desirable improvement. We recommend it as a cheap and convenient attachment, requiring but a moment to put on, effectually preventing wear and sticking of lifting rods, adding to the neatness of frames, and reducing the amount of oil required for lubricating the rods to the least possible quantity. They will not require oiling more than once in two or three weeks.

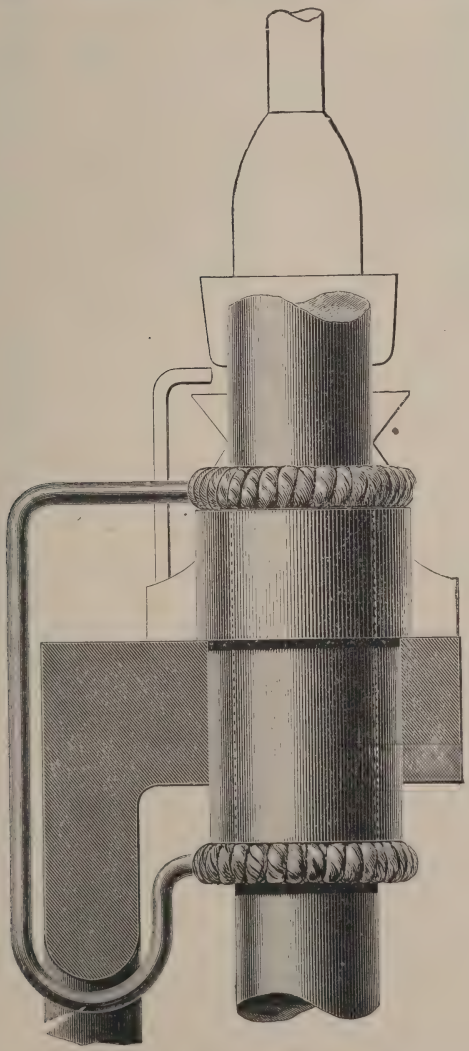
We have recently cut the price in two, giving strong reason for universal adoption.

SPECIFICATIONS FOR ORDERING SHAW & FLINN'S PATENT LIFTING ROD CLEANER.

Number and diameter of Lifting Rods.....
Width of upper and lower rails.....
Thickness of each front and back.....
Length, small diameter, and height above rails of bushings.....
Distance from back of rail to center of rod.....
If a guide for lifting rod is used below lower rail, give length where rod passes through.....

The thickness of front and back of rails is wanted in case a box or flanged rail is used.....

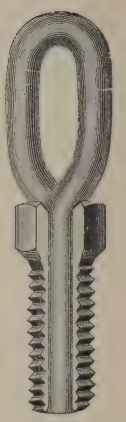
Blank specification, with diagrams for convenience in taking necessary measurements, will be sent on application.



SHAW & FLINN'S PATENT LIFTING ROD CLEANER.

May now be purchased at one-half former price.

SPEAKMAN'S PATENT LEVER SCREW.



Notice the present construction—a Steel Screw and a Steel Wire—unbreakable and indestructible.

The Speakman Lever Screw is constructed of two parts, a wire hook and a screw which rotates around the hook. The wire is headed so that the upward or downward movement of the screw carries the hook up or down the same vertical distance, without, however, causing it to rotate.

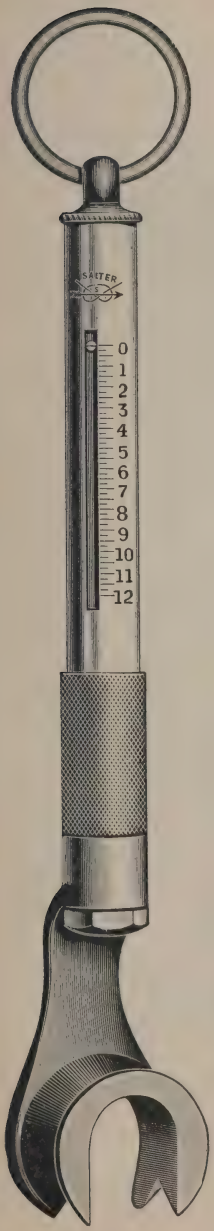
On ordinary spinning and roving frames the back weight levers get out of position constantly, causing an endless source of annoyance. The only way to adjust with the ordinary lever screw, is to stop two to four ends, take off the back weight, remove the lever from the stirrup and screw and use it as a lever to turn the screw up or down until it is properly adjusted. The disadvantages of this proceeding are known to every second hand. In the first place, the ends have to be pieced again and production is stopped from those rolls during the operation. The back weights are liable to be dropped on to the cylinder or bands, incurring a waste of time and perhaps damage. The lever will probably become bent, as it was never designed as a screw driver, and the stirrup often falls between the steel rolls, making serious repairs necessary.

Compare the above operation with that in use on the Speakman Screw. All that is needed is to turn the screw slightly by means of a wrench, without stopping an end or moving a piece. With the old screw, half a turn is the least you can get, while with the Speakman as much or as little rotation as is necessary may be obtained.

In ordering new frames it is inexcusable to accept the old style. It will pay well to change over old frames. Send us a quantity order with a sample of the screw you are using, and we will cut a similar thread without extra charge.

The careful spinner is ever on the watch for real improvements. It is mainly by the combination of small improvements that success is maintained.

We are now selling this device for four cents—a reduction of two cents from the former price. Surely no adverse reason against their universal use remains.

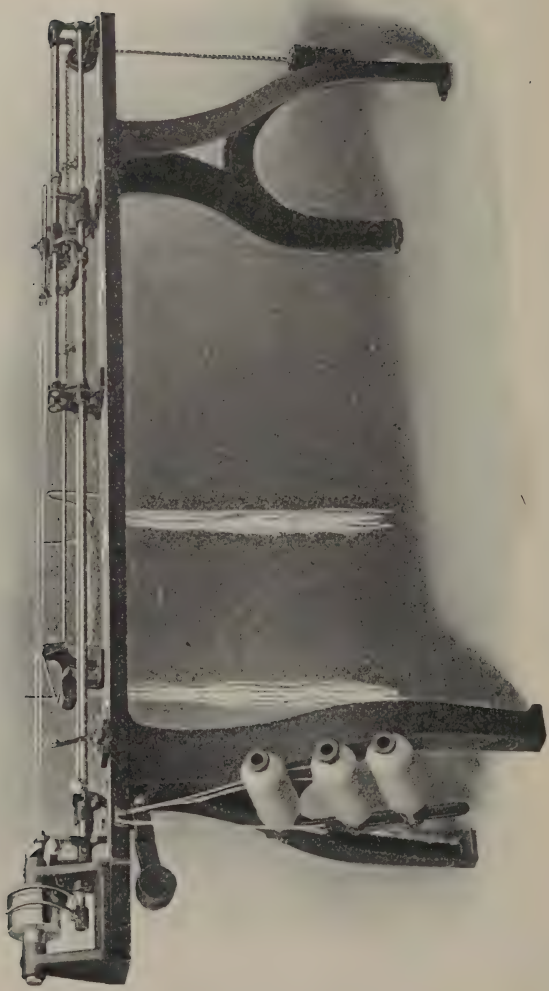


BAND TENSION SCALE.

This device is to the spinning room what an indicator is to the engine room. It multiplies the efficiency of the overseer, or second hand, although the results are shown at the coal pile, rather than in their immediate departments. It is, however, important to the spinning room itself, to have its bands well adjusted to a uniform scale of tension, so that they will wear longer, and protect the weave room against slack yarn. The band scale absolutely determines the exact tension of any band, or number of bands.

To use the scale, the frame must be stopped, and if the spindle is of the old type with a hook, the hook must be turned. The whorl of the scale is then applied by its slot, under the whorl of the spindle, which will thereby be raised, and the band is slipped off the spindle whorl onto the band scale whorl. By drawing the lower whorl even with the spindle whorl, the tension is shown on the scales. New bands should pull from three to four pounds. It is a great mistake to put them on at any higher tension. A spindle should run with a pull of one pound and if they do not turn freely with this tension, they either need oiling or are too tight in their bearings.

We charge $10 each for these scales, fitted with one whorl, and as the demand is not sufficient to warrant tools for making them in large quantities, there is no profit at this figure. They can be made to earn their cost many times over in a very short time, by intelligent use. **Send sample spindle with order.** This is absolutely necessary as we have so many styles it is not safe to use name or description.



OUR NEW RHOADES BANDING MACHINE.

OUR NEW BANDING MACHINE.

Our Mr. Rhoades has recently designed an entirely new model of banding machine, which incorporates many interesting features. The original construction was made in accordance with the patent of the late George W. Weeks, and has been the standard trade machine for making spinning and twisting bands for some twenty years. The general principle and construction is so well known that it is hardly necessary to explain the detail. It is semi-automatic in action, changing from twisting to doubling, and stopping itself when the band is done. It can be set so as to get any desired amount of twist, making either a hard or soft band. The twist will always be uniform. It can be run by a boy, and often obtains a product of 1500 bands a day. It is usually run at a speed of about 2,000 revolutions.

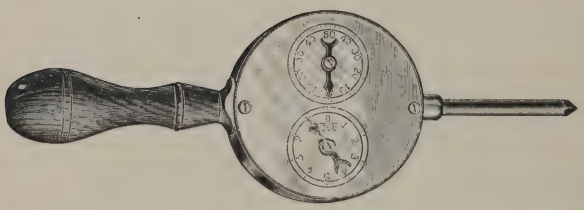
We recommend the use of roving as a material, though many mills use twisted yarn, and some run in a core of twine or linen thread. Some years ago we introduced the Watters marking attachment with great success, for the purpose of showing the band boy where the knot should be tied. With this means, an even tension can be had on all spindles. The attachment was so simple that it was difficult for many purchasers to understand why they should pay our original extra charge of $100, although we could easily figure that large mills might save several thousand dollars a year in power by its use. With our present machine, we not only throw in the Watters attachment **without any additional cost whatever**, but also furnish a more expensive and highly improved machine in other details, at the same old price formerly charged for the banding machine without the Watters attachment.

Our new machine is built with an iron frame, having no wood whatever in its construction. It is supplied with an automatic brake, acting on a drum near the belt pulley. The hooks are of new shape to aid in quick manipulation. The Watters marker has **an interrupted return motion to prevent spattering the ink.** A neat holding device is supplied to enable the operative to prepare a new band for attachment while a band is being twisted. The knife is easily removable for sharpening. The shipper handle is put in a more convenient position. We have a new style of holder for made bands. We furnish a chain, instead of letting the mill use a cord for the weight, and the weight itself is furnished with a grab hook, which engages the chain at any desired position, the extra chain coiling in a hollow in the weight. The band

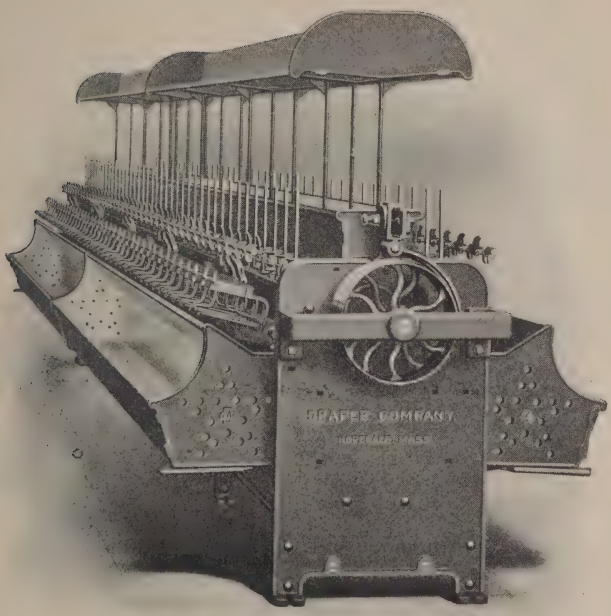
hook slide has a **marked scale** so that bands may be made to a definite, known length. The holder for the roving bobbins is adjustable to various positions.

We are now in competition with automatic banding machines, which have been introduced more or less within the last few years. As to their efficiency while in working condition, we have nothing to say, but believe that for the average mill our own machine is more readily adaptable to the various conditions demanded, and there is some question as to whether the extra attention necessary in keeping a complicated, automatic machine efficient, does not balance the slight cost of a cheap operative on our semi-automatic machine.

Our price of $65 should be attractive, and while this part of our business hardly demands much attention on our part, we are glad of the opportunity to present a machine the price of which cannot deter proper consideration by the purchaser.



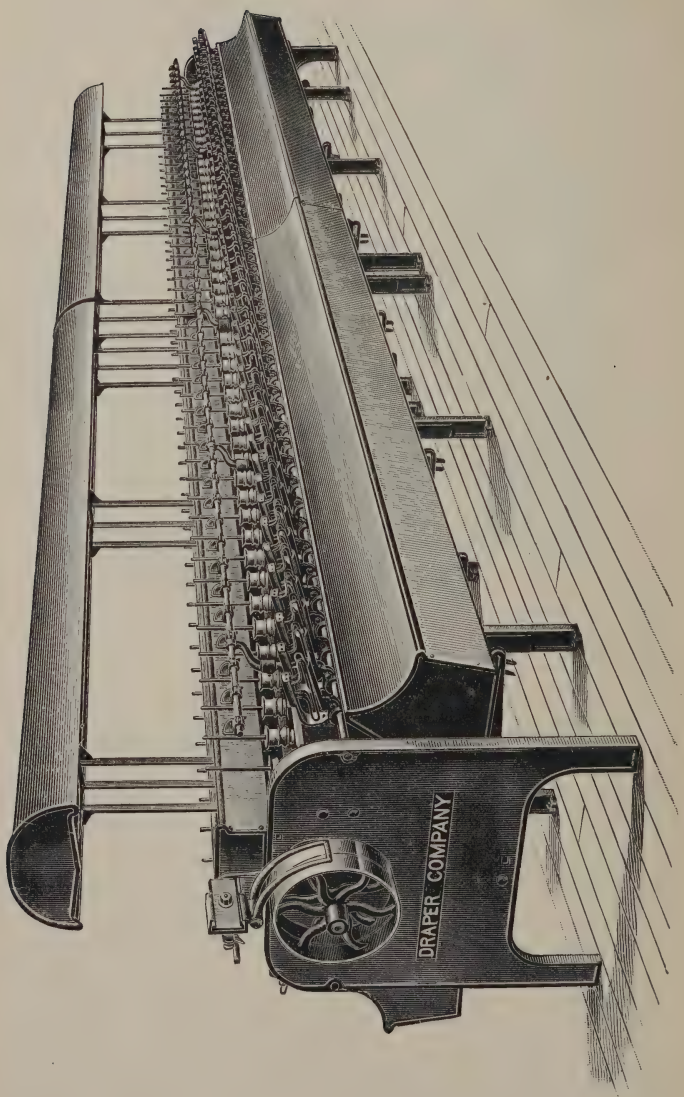
We supply speed counters like the above, when ordered. They are of great assistance in taking spindle speed, by connection with a piece of rubber tubing.



Model I.

HOPEDALE SPOOLERS.

We began building spoolers in the early seventies, when certain important inventions in bobbin-holders and guides came into our possession. We might easily have monopolized the spooler business during the life of these patents, as the use of the bobbin-holder became practically universal, but we preferred to allow other builders to use our improvements on royalty, rather than interfere with their established trade. We have continued to control the more important improvements in spooling as they matured, but while we continue to license other builders to use our bobbin-holders and guides, we retain many of the more recent inventions for our sole use. We think there is no question but that our spooler is superior to any other in the market, but it does not always get preference in sales because the builders of other spoolers usually build spinning frames also and sell both machines in the same order. We believe that clever buyers can insist on our spool-

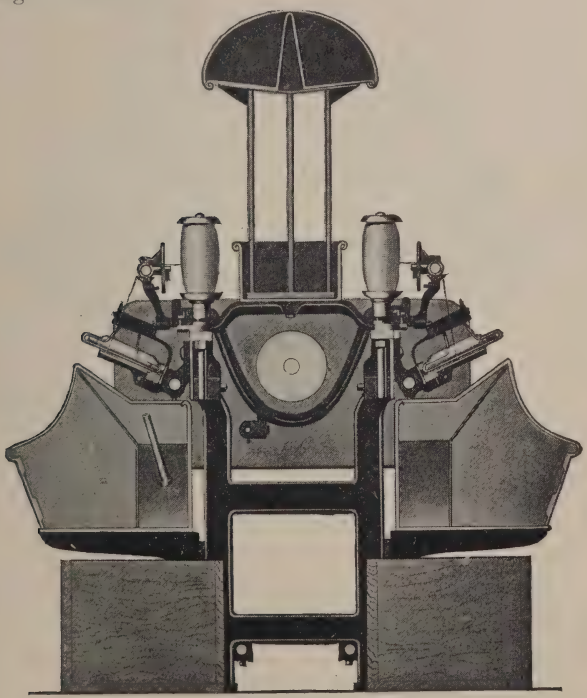


THE HOPEDALE SPOOLER. MODEL E.

Cut does not show adjustable legs, as on latest construction.

ers without sacrificing in cost on other machinery, and we see no reason why any mill should not have the very best machinery while the prices of the spoolers themselves do not materially differ.

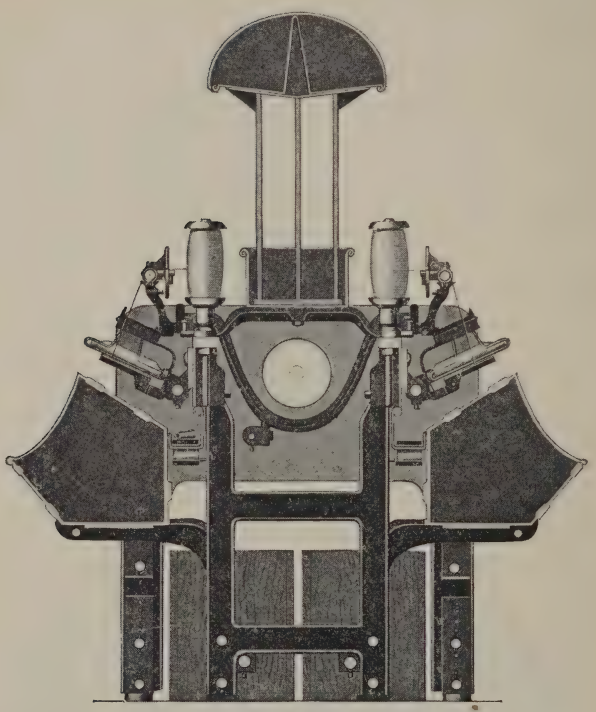
The spooling of yarn involves a high percentage of labor cost per machine, and it is of the greatest importance to reduce the labor so far as possible. Our latest spooler has belts or chutes to handle the empty bobbins, using our patent side-discharge bobbin-holder.



PATENT MODEL H BOBBIN CHUTE SPOOLER.

Our bobbin-chute spooler shown in sectional view, allows empty bobbins to drop through a chute into receiving boxes resting on the floor.

Our new patent travelling belt type, also shown in sectional view, is novel in using two narrow belts to deliver bobbins into separate boxes so that each spooler tender has a separate box, and the overseer can more easily follow up the work done. We also make a travelling belt spooler of the single-belt type for use with the old form of bobbin-holder, which also contains many important improvements over those of other builders.

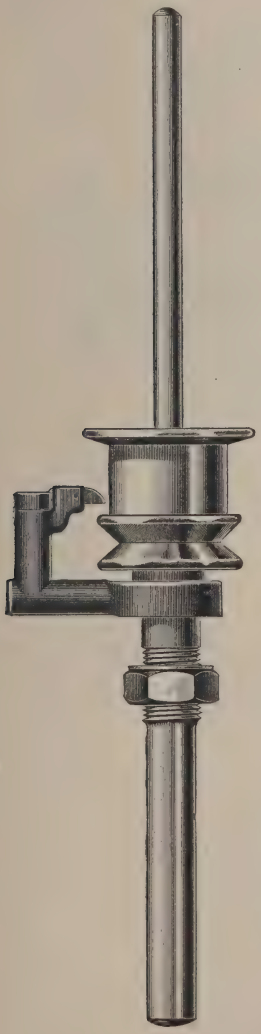


Travelling Belt Spooler for Use with New Bobbin-Holder. Model I.

Our regular model E spooler is still in great demand by customers who have this pattern and do not care to have more than one style of machine.

Our most important improvement of recent years is our new patent traverse motion, designed by Mr. Rhoades to do away with the old-fashioned lifting rods. With the new system the guides are not moved in a vertical line, but the rod carrying the guides moves on the arc of a circle so that the yarn which runs through the guides has a continual lengthwise motion, keeping them free from lint, saving trouble in cleaning, preventing breakage of yarn and making less knots to be tied. The guides are not worn in ridges, and there are no sliding rod bearings to stick and give trouble. Our customers are most enthusiastic and many of them insist on having this motion applied to our older styles of spooler, when ordering old patterns.

Our new traverse motion is so geared that the change of one tooth in one gear varies the amount of traverse 1-8 of an inch. Another change gear governs the speed to allow quicker or slower, traverse. We use our patent compound rocker arm on all our spoolers, to prevent damage in case a falling spool gets under a travelling rocker.

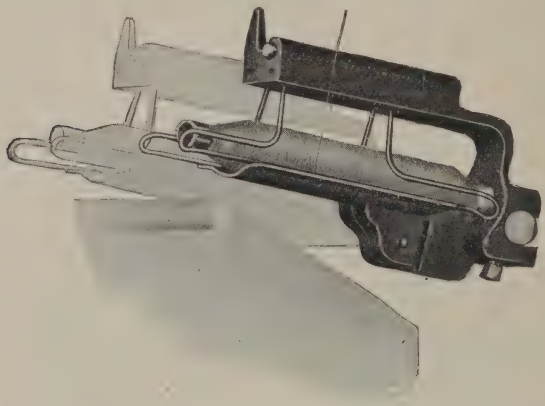


PATENT SPOOLER SPINDLE.

Taking up our machine in detail, we first point to the general design of the machine as a whole. It is a substantial, sensible model, with smooth surfaces for easy cleaning, and abundant strength where necessary. It is entirely constructed of iron and steel. We were the first builders to avoid wood in such construction. Our stamped metal creels and boxes save in wear and repair as compared with those of wood. We build our frame with adjustable legs, so that it can be accommodated to different sizes of help. This construction has brought about amusing comment from those interested in the child labor discussion. It is our business to give our customers what they want, and so long as they use different sizes of help, we are prepared to supply them with suitable machinery. As a matter of fact, there are great differences in size of operative irrespective of age.

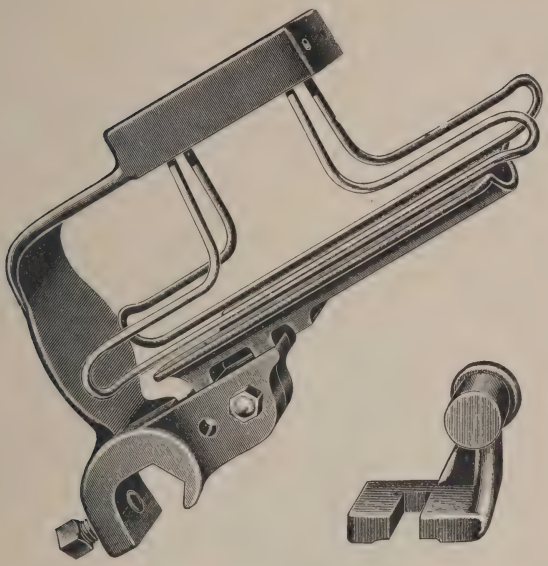
Our spindles are of the very latest single-rail pattern, with Woodmancy retaining-lock and oil cover. No one questions our ability to make satisfactory spindles of any type.

The Rhoades side discharge bobbin-holder is only used with our chute, or belt spoolers. The cut illustrates how the top may be tipped to eject an empty bobbin at the side. The motion necessary is hardly perceptible, a mere wave of the hand being sufficient to empty several holders if several adjacent holders contain empty bobbins at one time.



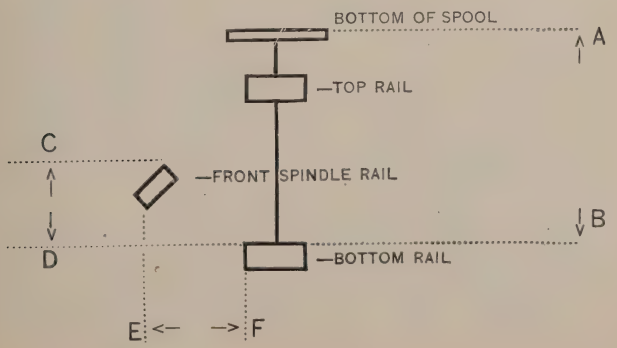
OUR NEW RHOADES PATENT BOBBIN HOLDER.

SHOWING OPERATION BY FINGER TO EJECT EMPTY BOBBIN AT SIDE.



LAWRENCE PATENT BOBBIN HOLDER.

In bobbin holders, we have the regular Lawrence adjustable pattern, which may be used for different sizes of bobbin and different yarn diameters, requiring only change in the wires themselves for different yarn. When a round rod is not found on old styles of spoolers, we use the small foot piece shown at the right of the cut. We furnish side spindles instead of bobbin holders when demanded.



SPECIFICATION FOR LAWRENCE BOBBIN HOLDER

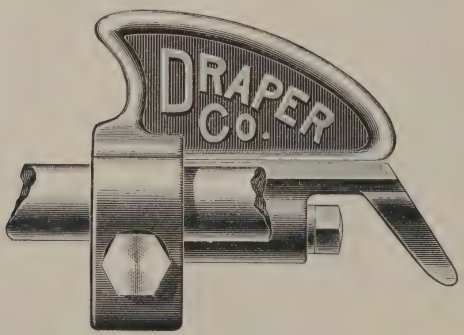
ORDERED FROM DRAPER COMPANY, HOPEDALE, MASS.

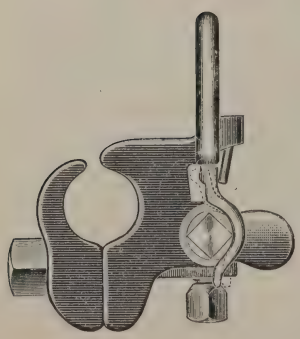
QUESTIONS TO BE ANSWERED.

How many Spoolers?.....
No. of Spindles each?.....
Traverse of Bobbin?.....
No. of Yarn?.....
Size Ring?.....
To attach to Round Rod or Flat Rail?.....

Additional information wanted if Round Rods and Stands are to be applied.

What make Spooler?.....
Gauge?.....
Distance between end Spindles?.....
Distance from Bottom of Spool to top of Bottom Rail (A to B in diagram).....
Distance from top of Front Spindle Rail to top of Bottom Rail (C to D).....
Distance from lower corner of Front Spindle Rail to outer face of bottom Rail (E to F).....

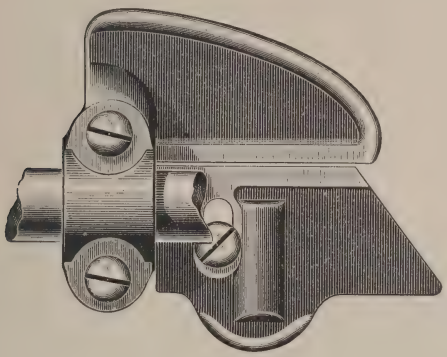


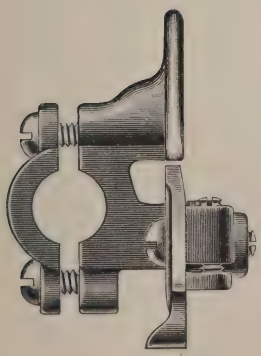


IMPROVED NORTHROP GUIDE.

We make spooler guides in several patterns, but our customers have shown preference for the Improved Northrop and Lawrence patterns. The Improved Northrop Patent Guide has its lower jaw held by an eccentric bolt, enabling a positive and accurate adjustment without disturbing the fastening device.

If the slot becomes clogged, the lower jaw may become tipped slightly, exposing the edge so that lint may be removed with ease. The slot remains the same width in spite of this motion, thereby preventing the operative from increasing the width by any designed manipulation. With this guide, the rod on which the yarn rests may be turned to present a new wearing surface without changing the adjustment of the guide slots, as with the old Northrop pattern.





THE LAWRENCE GUIDE.

The Lawrence Patent Guide is even easier to clean than the Improved Northrop, as the lower blade is controlled by a hidden spring, which may be compressed temporarily for removal of lint. A separate screw adjustment enables change in width of slot without affecting the fastening device. This guide is also designed so it cannot be opened through any ingenuity of the operative except through positive change of the adjustment.

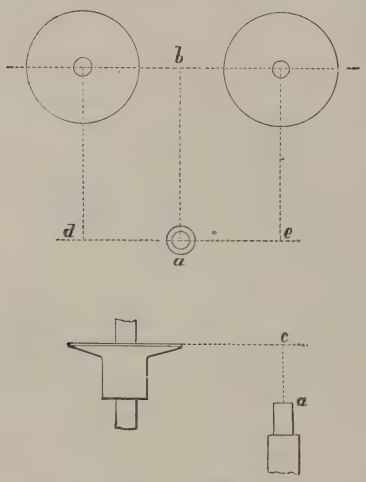
We have special patterns of both of these guides with longer jaws for use with cone winders and we are developing quite a trade in this line with customers who know the merits of our guides on their common spoolers.

SPECIFICATIONS OF SPOOLER GUIDES ON SPOOLERS MADE BY OTHER BUILDERS.

ORDERED FROM DRAPER COMPANY, HOPEDALE, MASS.

For.....

Date.....190



Answer the following questions:

Which Guide will you have, Improved Northrop or Lawrence ?.....

Give number of Spoolers?.....

Number of Spindles in each?.....

Builder of Spooler?.....

Are Lifting Rods in the Spindle Rail?.....

Are Lifting Rods in front of the Spindle Rail?.....

Are Lifting Rods behind the Spindle Rail?.....

Give total length between end Spindles.....ft.....in.....

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

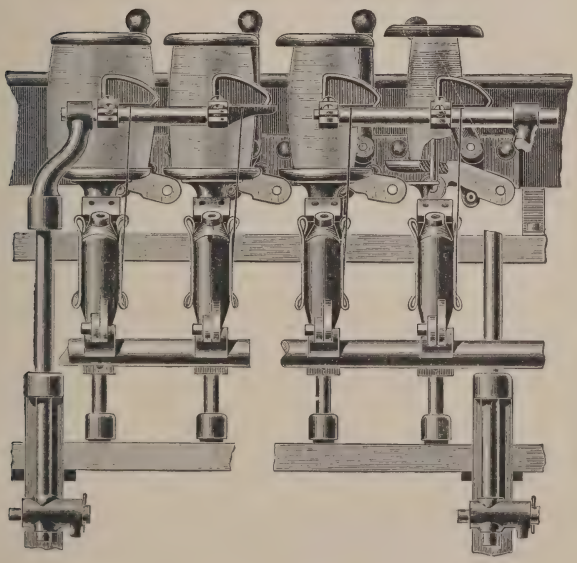
31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

Mark X between Spindles where Lifting Rods come. If they come opposite Spindles put X on the Spindle line.

Distance between centres of adjacent Spindles, that is, the gauge?.....

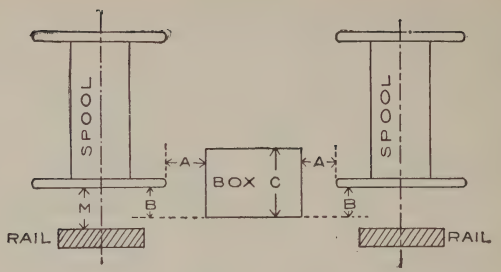
Distance A to B (Diagram No. 1).....

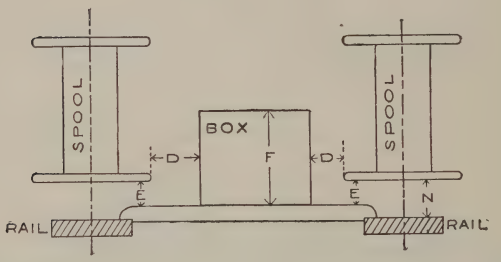
Distance A to C? (Diagram No. 2. When lifting rod is at the lowest point of traverse).....
Distance D to A on Diagram No. 1?.....
Distance A to E on Diagram No. 1?.....
Distance from top of lifting rod at lowest point of traverse to top of upper bearing which rod runs through?.....
Distance from bottom of lifting rod at highest point of traverse to bottom of lower bearing which rods run through?.....
Size and shape of top three inches of lifting rod? (See Diagram No. 2).....
Are rods and stands wanted with guides?.....If so, answer the following questions:
No. of Samsons.....
Distance between Samsons.....



PATENT SPOOL LIFTING DEVICE.

This attachment allows the operative to lift the spool by a simple lever movement, in order to aid while tying knots. It has been found of considerable assistance when heavy spools are used. Its additional parts involve an extra charge of 25 cents per spindle.





SPECIFICATIONS FOR SPOOL LIFTING DEVICE

ORDERED FROM DRAPER COMPANY.

For.....

Date.....190.....

Give maker of spooler.....

Give distances A-A..... Upper cut is used for single rail spooler.

" " B-B.....

" " C-C.....

" " M-M.....

Give distances D-D..... For double rail spooler.

" " E-E.....

" " F-F.....

" " N-N.....

SPECIFICATIONS OF SPOOLERS

ORDERED FROM DRAPER COMPANY, HOPEDALE, MASS.

Name..... Date.....19.....

Place.....

Ship to..... Via what route.....

How many spoolers?.....

How many Spindles in each?.....

Single or Double Rail Pattern of Spooler, "E," "H," or "I" (see cuts).....

Send sample Spindle, if top is to match others? .....
What length of traverse?.....
What gauge? .....
Bobbin Holders or Side Spindles? .....

Rhoades patent Bobbin Holder recommended for "H" and "I" Model when "H" has chutes and "I" has belt; Lawrence patent if without chutes or belts. On "E" Model, only Lawrence pattern can be used. **We never recommend bobbin holders for spooling twister bobbins.**

Send Bobbin full of Yarn.....
Send Sample Spool .....
What Style Guide? (See Back).....
Give size of Spinning Ring used.....
Give number of Yarn to be spooled.....
Bobbin Chutes. Will you have?.....

On "E" Model Spoolers we charge 15 cents per spindle, extra. We furnish without extra charge on "H" Model when Rhoades Bobbin Holders are ordered. We do not use chutes on "I" Model.

Will you have Spool Raising Device? (25 cents per spindle extra) (See cut) .....
(Recommended for Heavy Spools.)
Will you have Top Creel?.....
Will you have Side Boxes or Shelves? (If Shelves, give outside measurement of height and width of Doffing Boxes)
Will you have Top Creel and Boxes of Steel or Wood? We recommend steel .....
Belt Above or Below?.....
What size Pulley?.....Face.....
Shall Machines be Shod or Taken Down for Shipping? .....

Our spoolers will run as fast as any other, but we recommend care in high speeds, advising a larger number of spindles rather than give too great strain on the yarn. While we give production at different speeds, we recommend the lowest of the tables.

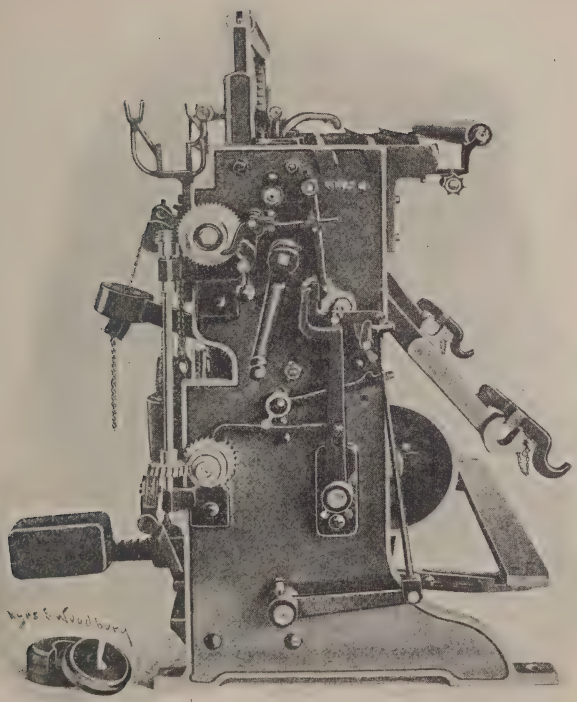
DIMENSIONS OF SPOOLERS.

Gauge.	3½	3¾	4	4¼	4½	4¾	5	5¼	5½	5¾	6	6½
Diam. head of spool.	2¾	3	3¼	3½	3¾	4	4¼	4½	4¾	5	5¼	5¾
No. of spindles.	Lengths in feet and inches.											
60	10 3	10 11	11 6	12 1	12 8	13 4	13 11	14 6	15 1	15 9	16 4	17 6
80	13 2	14 0	14 10	15 8	16 5	17 3	18 1	18 11	19 8	20 6	21 4	22 11
100	16 1	17 2	18 2	19 2	20 2	21 3	22 3	23 3	24 3	25 4		
120		20 3	21 6	22 9	23 11	25 2	26 5	27 8				
150				28 0	29 7							

Width, including bobbin boxes, four feet.
Weight, from thirty to forty pounds per spindle complete.

PRODUCTION OF SPOOLERS.

Dimensions of Spool.		Number of Yarn.	Revolutions per minute of the			Number of Rabbeth spindles to 1 spooler spindle, running at 825 revolutions per minute.
			Cylinder, 200. Spindle, 750.	Cylinder, 220. Spindle, 825.	Cylinder, 240. Spindle, 900.	
Length between heads.	Diam. of heads.		Pounds per spindle per week.			
6	5	8	64.3	70.7	77.1	
		10	51.4	56.6	61.7	12
		12	42.9	47.1	51.4	
		14	36.7	40.4	44.1	
		16	32.1	35.3	38.6	13
5	4	18	28.6	31.4	34.3	
		20	25.7	28.3	30.9	
		22	23.4	25.7	28.1	14
		24	21.4	23.6	25.7	
		26	19.8	21.8	23.7	
		28	18.4	20.2	22.0	15
		29	17.7	19.5	21.3	
		30	17.1	18.9	20.6	
		32	16.1	17.7	19.3	16
		34	15.1	16.6	18.1	
4½	3½	36	14.3	15.7	17.1	17
		38	13.5	14.9	16.2	
		40	12.9	14.1	15.4	18
		44	11.7	12.9	14.0	19
		50	10.3	11.3	12.3	20
3½	3¼	60	8.6	9.4	10.3	21
		70	7.3	8.1	8.8	23
		80	6.4	7.1	7.8	25

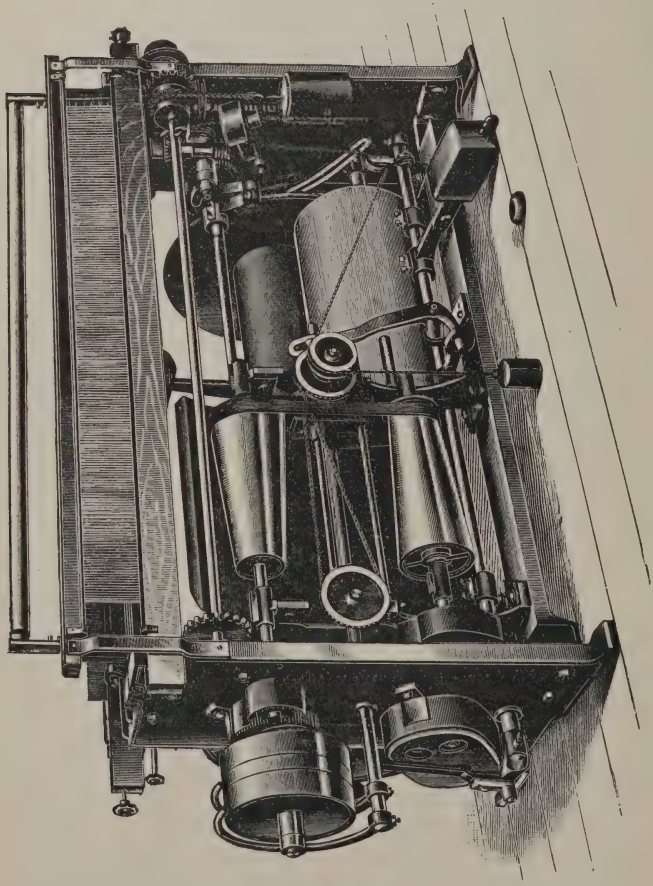


MODEL F FOR FINE YARNS.

HOPEDALE WARPERS.

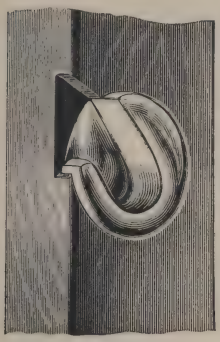
We make a great variety of beam warpers to meet the varied demand. Warpers have always been one of our distinct specialties, and we have controlled the main bulk of the trade for some thirty years. Every important improvement known in this art within that period has been introduced by us. As patents expire, our competitors naturally take advantage of our methods; yet we to-day still control many valuable features which are not open to them. As to prices, we can easily meet competition when furnishing a similar, or even better machine. We naturally do not give away our best features which the competitors cannot furnish.

Taking our various patterns in the order of their novelty, we first illustrate our special pattern for fine yarn. This model, as shown, is the most narrow type ever presented. We accomplish this reduction in width by taking out the usual measuring roll and using the driving drum itself for that purpose. Everybody can understand how much more available a narrow pattern is for the operative in piecing the ends. By taking out the measuring roll, we also remove the yarn strain formerly necessary to drive the drum. Accurate measurements have shown that 33 per cent. of the former strain on the yarn was utilized for this purpose.



MODEL E.

The next back view of Model shows the cone drive, small cylinder, and other important improvements. We also make an older pattern with the cone drive, and large cylinder, and also a fourth style without the cone drive which also uses the large cylinder.



A warper contains the generic idea of winding a beam of yarn from a creel full of spools. Starting at the creel, it is found that it is essential for the spool skewers to have proper bearings. For fine yarn, there is nothing so neat and efficient as our patent glass step shown in the adjoining illustration. We also furnish iron or wood bearings, if desired.

The yarns passing from the spools through the warper are at first led through the separating comb, which has been much improved in our later constructions. Our rise roll has also met with great favor since we adopted the use of positive gearing in place of the old rope and scroll system. The roll must now move in a parallel path at all times without any chance of bending or sticking. A rise roll is far preferable to a drop roll as it keeps the yarn up out of the dirt and saves one knot when piecing a broken end.

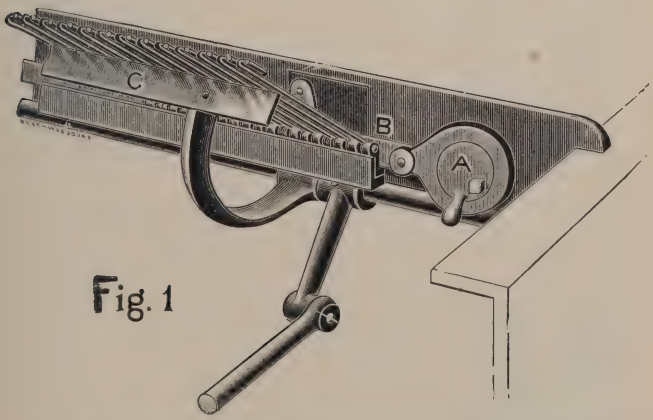


Fig. 1

Our stop motion is the Improved Walmsley, involving the principle of a hinged wire which relieves the yarn from weight so far as possible, as compared with the drop wire system. With individual drop wires it is possible for individual wires to get loose, or be removed, so that the warper may run

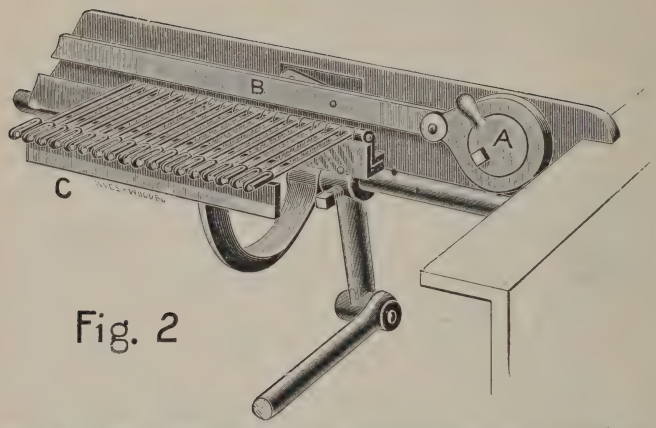


Fig. 2

at times with broken ends; in fact, these wires have often been pulled out of place by the yarn snarling around them and carried with the cloth to the printing machine where they have done great damage to the cylinders. Our present stop-motions are provided with a locking bar and eccentric release, which enables the removal of a group of wires at any point. Fig. 1 shows the locking bar in position, and Fig. 2 shows it raised for the purpose of liberating the groups. While we recommend the Walmsley Motion, we can, of course, furnish any regular warp stop-motion in place of it, if desired.

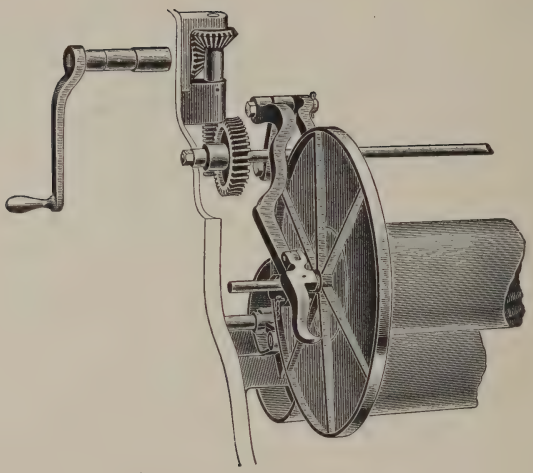
Our latest patent drop-wires are made with flattened tops to reduce friction and the loops are also set cornering to allow the thread a free passage. We aim to reduce the strain on the yarn by all possble means to deliver a stronger warp to the loom.

On the warpers which still use the measuring rolls, we have adopted brass tubing instead of tin, as we find it more uniform in circumference.

Our Cone Drive is now so well known that it is hardly necessary to explain its principle in great detail. All know, or should know, that the tension changes materially in winding yarn off of spools which change constantly in their yarn diameter. The cone drive compensates for this by regulating the speed of the drum so that the tension on the yarn is kept uniform. This naturally increases the production of the warper by winding faster than usual throughout part of the process. It may be better for the yarn to regulate the speed so that the production will be no greater than before, but in practice the cone warper usually attains higher production, as the average speed can be fully 50 per cent. greater than the speed of the common warper without adding to the strain. As the warper is stopped for tying-in about one-half of the time, the net gain is not 50 per cent., but 33 per cent. It is wholly possible for four cone warpers to do the work of five common, and still reduce strain on the yarn.

In equipping a new mill, the saving of floor space, and number of machines, is of course, a most important item, but we believe that the saving of the strain on the yarn is of still greater value. Now that automatic weaving has come to stay, every effort should be made to supply warps to the looms that will weave with the lowest possible percentage of breakage. The cone drive cannot be attached to old warpers.

Our Low Cylinder is another improvement that is universally commended. By use of an eccentric drive, we can overlap the center of the driving drum, enabling us to drive a 26-inch beam head from a 12-inch cylinder. This feature may be noted in the cut on the next page, which also shows our beam doffer. The small cylinder enables the warper to be made four inches lower and four and one-half inches narrower, so that the operative may tie in broken ends with greater ease, also allowing the use of smaller help.



BEAM DOFFER.

The Beam Doffer originated with us, and is a great labor saver. The warper tender herself may deliver the beam to a truck, if necessary, and in any event but one operative is necessary, instead of requiring the use of two. The new beam is raised to place by the same agency.

We have the simplest Slow Motion on the market, and our Reeds and Combs also present important improvements. In our present comb, we use a round wire which presents a smoother surface for the yarn, the alternate wires being offset so as to give the threads perfect freedom of movement, even when the wires are quite closely together. We put our combs in metal cases of patented construction increasing their wear and durability.

Another novelty is the Straw Registering Device, which detects the number of times the warper stops for broken threads, thus giving the superintendent an accurate and daily record of the condition of the warp yarn, as made in the mill. The device consists of a dial and pointer in operative connection. It is only applied on special order, as it involves an extra expense for royalty.

Take notice that even when competing with our cheaper warper, we still give the advantages of the Improved Walmsley Stop-Motion, Geared Rise Roll, new Slow Motion, and Improved Reeds and Combs.

We now classify our warper models as follows:

A model—Old pattern straight back—not sold now.

B model—Our second construction—also out of date and not sold now.

C model—First model to have the Hicks cone, though also built without. Made with 18 and 20 inch cylinders.

D model—Special low model 18 inch cylinder—three inches lower than C.

E model—First low cylinder warper—12 inch cylinder—with measuring roll. Our popular model for several years past.

F model—Fine yarn warper, low cylinder, measures from cylinder, ball bearing rolls, takes up to 24 inch beam head, with 9 or 12 inch barrel.

G model—Low cylinder—measures from cylinder, takes up to 28 inch beam head, with 9 inch barrel.

H model—low cylinder—measures from cylinder, takes up to 32 inch beam head, with 9 inch barrel.

I model—Low cylinder—measuring roll—takes up to 32 inch beam head, with 9 inch barrel.

All models from C to I are made either with or without the Hicks cone drive.

The C model is the cheapest construction when made without Hicks Drive. It has such recent improvements, however, as the Improved Walmsley Stop Motion, Geared Rise Roll, new Slow Motion and Improved Reeds and Combs. Beam Doffer and Hicks Drive can be added.

Straw Registering Device applied when ordered.

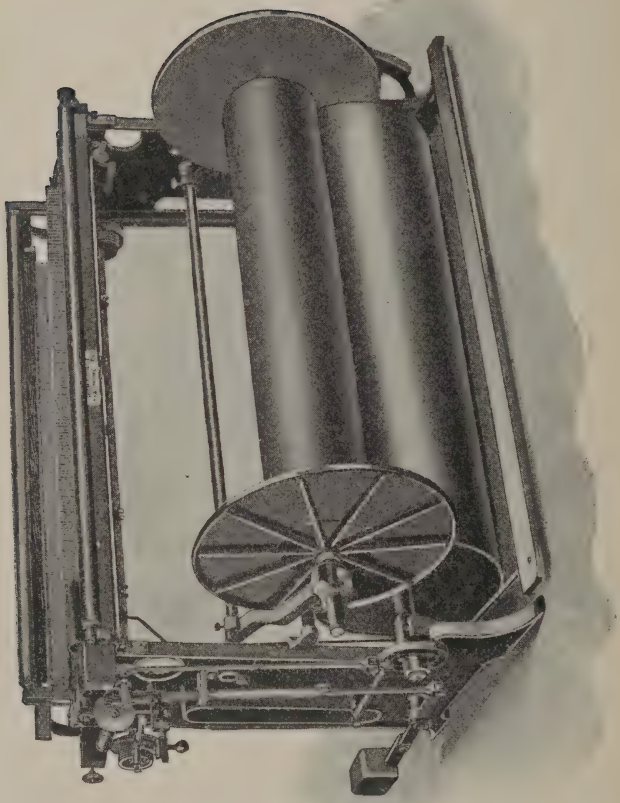
The following tabular statements will be found very nearly correct, and handy for reference in this connection.

Weight of yarn on a spool with barrel 1½ inches in diameter:—

With 5-inch head, 6-inch traverse, 1.9 lbs.
" 5 " " 5 " " 1.6 "
" 4 " " 5 " " 1.0 "
" 3½" " 4½" " 0.7 "

Weight of yarn on a beam 54 1-4 inches between heads, and with a 9-inch barrel:—

With 26-inch heads, 420 lbs.
" 24 " " 350 "
" 22 " " 285 "
" 21 " " 255 "



C Model Warper.

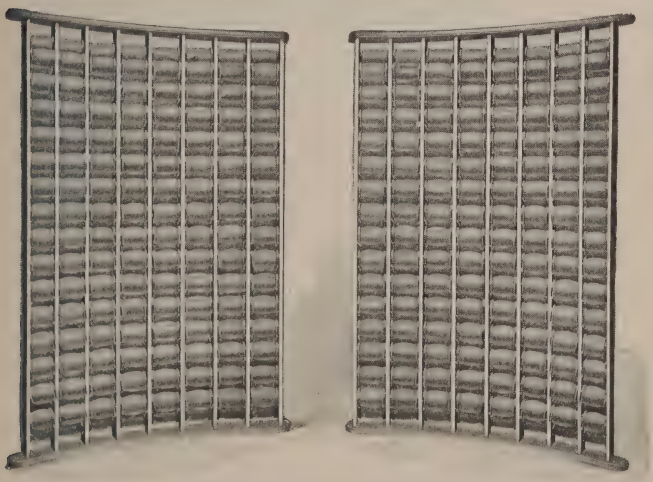
SPECIFICATIONS OF SLASHER WARPERS.

Ordered from the Draper Company, Hopedale, Mass.

Name..... Date..... 19.....
Place.....
Ship to..... Via what route.....
How many Warpers with driving pulleys on Right hand.....
How many Warpers with driving pulleys on Left hand.....
What model.....
Rise or Drop roll machine.....
What length of cylinder.....

Our usual length is 54 inches.

Diameter of Beam Heads.....
Diameter of Barrel of Beams.....
Largest number of Threads on Section Beam.....
Clock for how many Raps?..... No. of yards per Rap?.....
Will you drive the Beam with Threads over it or under.....
Do you belt from above or below.....
Will you have back combs, high reed, or low reed?.....
Reeds are covered on top; combs are not. High reed, 5″ between top rail and case, low reed 3″.
How many section beams.....
How many V Creels.....Number of Spools.....
How many High.....Long.....
What height is your room, floor to ceiling.....
Will you have Iron or Glass Creel Steps.....
Send sample spool, also skewer, if used.....
Do you want the Hicks Cone Drive.....
Do you want the Beam Doffer.....
In sending samples please specify where from.
Special Specification when Balling Motion is desired.



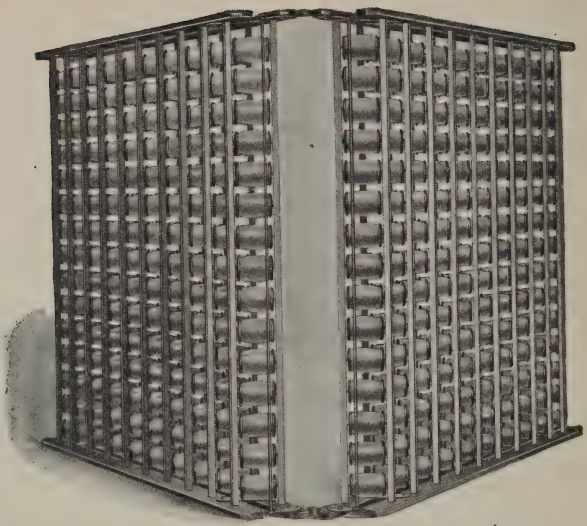
CIRCULAR CREEL.

DIMENSIONS OF WARPERS AND CREELS.

One 54-in. Cylinder Warper occupies space 7 ft. by 3 ft. 6 in. —Large Cylinder.

One 54-in. Cylinder Warper occupies space 7 ft. by 3 ft. 1½ in. —Small Cylinder.

Above figured with 24 inch beam head. Add extra width for large beams.



V Creel.

MEMORANDUM GIVING REGULAR SIZES OF V WARPER CREELS.

360	Spools,	12 x 15	512	Spools,	16 x 16
364	"	13 x 14	532	"	14 x 19
384	"	12 x 16	540	"	15 x 18
390	"	13 x 15	544	"	16 x 17
392	"	14 x 14	570	"	15 x 19
416	"	13 x 16	576	"	16 x 18
420	"	14 x 15	600	"	15 x 20
448	"	14 x 16	608	"	16 x 19
450	"	15 x 15	640	"	16 x 20
476	"	14 x 17	680	"	17 x 20
480	"	15 x 16	720	"	18 x 20
504	"	14 x 18	750	"	15 x 25
510	"	15 x 17	800	"	16 x 25

One Warper and Creel occupies about 8 ft. by 13 ft.
Driving pulleys 10 in. diameter, 2 in. face.
Pulley on counter shaft should be 6 in. face to cover loose and slow motion pulleys on Warper.

SPECIFICATIONS FOR WARPER CREELS

ORDERED OF DRAPER COMPANY.

Ordered by.....Date.....
Place.....
Ship to.....Express or Freight.....
How many Creels.....
"V" or Circular.....
Number of Spools each.....Height of Ceiling.....
Spools High.....Long.....
Size Spool.....Traverse.....Head.....
If Circular creel give exact length of skewer or send sample.
Iron Steps, Glass Steps, or Cut in Bearings.....

Rule for finding the number of pounds of yarn on a beam.

Multiply the sum of the diameters of the barrel and beam heads by the difference of their diameters, then multiply by .7854, and then multiply by the length between the heads, giving the cubic inches of yarn on the beam when full. For instance, with a beam 9″ barrel and 24″ head, and 54 1-4″ between heads:

$9+24\times15\times.7854\times54\frac{1}{4}=21090.935+$ cubic inches yarn in full beam.

$21090.935\div60=351+$(pounds).

To get the length of the yarn on beam, multiply number of yarn by 840, which gives the number of yards in one pound, then multiply by number of pounds of yarn in beam. Divide the product by number of ends run in warper to find the length of warp.

The following tables show the number of pounds warped on a Hopedale slasher Warper, per week of sixty hours, at different speeds of cylinder and for different numbers of ends and sizes of yarn. In these tables the actual amount warped is assumed to be two-thirds of the theoretical amount. In figuring for a Cone Warper, take the average speed of cylinder from empty to full beam.

WARPER TABLES.

I. REVOLUTIONS PER MINUTE OF CYLINDER, 30; PULLEYS, 163.

Number of ends. / Number of yarn.	260	300	320	340	360	380	410	440
	Pounds warped in sixty hours.							
8	4,179	4,821	5,143	5,465	5,786	6,107	6,589	7,071
10	3,343	3,857	4,114	4,372	4,629	4,886	5,271	5,657
12	2,786	3,214	3,429	3,643	3,857	4,071	4,393	4,714
14	2,388	2,755	2,939	3,123	3,306	3,490	3,765	4,041
16	2,089	2,411	2,571	2,733	2,893	3,053	3,295	3,535
18	1,857	2,143	2,285	2,429	2,571	2,714	2,929	3,143
20	1,671	1,928	2,055	2,186	2,314	2,443	2,636	2,829
22	1,519	1,753	1,870	1,987	2,104	2,221	2,396	2,571
24	1,393	1,607	1,714	1,821	1,929	2,036	2,197	2,357
26	1,286	1,483	1,582	1,681	1,780	1,879	2,027	2,176
28	1,194	1,377	1,469	1,561	1,653	1,745	1,883	2,021
29	1,152	1,330	1,418	1,507	1,596	1,685	1,818	1,950
30	1,114	1,285	1,371	1,457	1,543	1,629	1,757	1,885
32	1,044	1,205	1,285	1,346	1,447	1,527	1,647	1,768
34	983	1,135	1,210	1,286	1,361	1,437	1,551	1,664
36	929	1,071	1,143	1,214	1,286	1,357	1,464	1,571
38	880	1,015	1,083	1,150	1,218	1,285	1,387	1,489
40	836	964	1,029	1,093	1,157	1,221	1,318	1,414
44	760	877	935	993	1,051	1,110	1,198	1,286
50	669	771	823	874	926	977	1,054	1,131

II. REVOLUTIONS PER MINUTE OF CYLINDER, 33; PULLEYS, 180.

Number of ends. / Number of yarn.	260	300	320	340	360	380	410	440
	Pounds warped in sixty hours.							
8	4,597	5,303	5,657	6,011	6,365	6,718	7,248	7,773
10	3,677	4,243	4,525	4,809	5,091	5,375	5,799	6,223
12	3,065	3,535	3,771	4,007	4,243	4,479	4,832	5,185
14	2,627	3,030	3,233	3,435	3,637	3,839	4,142	4,445
16	2,298	2,652	2,829	3,006	3,182	3,359	3,624	3,889
18	2,043	2,357	2,514	2,671	2,829	2,985	3,221	3,457
20	1,839	2,121	2,263	2,405	2,546	2,687	2,899	3,111
22	1,671	1,929	2,057	2,186	2,315	2,443	2,635	2,829
24	1,532	1,768	1,885	2,003	2,121	2,239	2,416	2,587
26	1,415	1,631	1,740	1,849	1,958	2,067	2,230	2,393
28	1,313	1,515	1,616	1,717	1,818	1,919	2,070	2,223
29	1,268	1,463	1,560	1,658	1,755	1,853	2,000	2,146
30	1,225	1,414	1,509	1,603	1,697	1,791	1,933	2,074
32	1,149	1,326	1,414	1,503	1,591	1,679	1,812	1,945
34	1,081	1,248	1,331	1,415	1,497	1,581	1,706	1,831
36	1,021	1,179	1,257	1,335	1,415	1,493	1,611	1,729
38	968	1,117	1,191	1,265	1,340	1,414	1,526	1,637
40	919	1,061	1,131	1,202	1,273	1,343	1,450	1,555
44	836	964	1,029	1,093	1,157	1,221	1,318	1,415
50	735	849	905	961	1,019	1,075	1,159	1,245

WARPER TABLES. — *Continued.*

III. REVOLUTIONS PER MINUTE OF CYLINDER, 36; PULLEYS, 196.

Number of ends.	260	300	320	340	360	380	410	440
Number of yarn.	Pounds warped in sixty hours.							
8	5,015	5,785	6,171	6,557	6,943	7,329	7,907	8,485
10	4,011	4,629	4,937	5,246	5,555	5,863	6,325	6,789
12	3,343	3,857	4,181	4,372	4,629	4,885	5,271	5,657
14	2,865	3,305	3,527	3,747	3,967	4,188	4,519	4,849
16	2,507	2,893	3,085	3,279	3,471	3,664	3,953	4,243
18	2,229	2,571	2,743	2,915	3,085	3,257	3,515	3,771
20	2,005	2,315	2,468	2,623	2,777	2,931	3,163	3,395
22	1,823	2,104	2,244	2,385	2,525	2,665	2,875	3,085
24	1,671	1,925	2,057	2,185	2,315	2,443	2,636	2,829
26	1,543	1,780	1,899	2,017	2,136	2,255	2,433	2,611
28	1,433	1,653	1,763	1,873	1,983	2,094	2,259	2,425
29	1,383	1,596	1,703	1,809	1,915	2,021	2,181	2,341
30	1,337	1,543	1,645	1,749	1,851	1,955	2,109	2,263
32	1,253	1,447	1,543	1,639	1,736	1,832	1,977	2,121
34	1,180	1,361	1,452	1,543	1,633	1,725	1,861	1,997
36	1,115	1,285	1,371	1,457	1,543	1,629	1,757	1,885
38	1,056	1,219	1,299	1,380	1,461	1,543	1,665	1,787
40	1,003	1,157	1,235	1,311	1,389	1,465	1,581	1,697
44	912	1,052	1,123	1,192	1,262	1,332	1,437	1,543
50	806	925	987	1,049	1,111	1,171	1,265	1,357

IV. REVOLUTIONS PER MINUTE OF CYLINDER, 40; PULLEYS, 218.

Number of ends.	260	300	320	340	360	380	410	440
Number of yarn.	Pounds warped in sixty hours.							
8	5,571	6,428	6,857	7,286	7,715	8,143	8,785	9,428
10	4,457	5,142	5,485	5,828	6,171	6,515	7,028	7,543
12	3,715	4,285	4,571	4,857	5,143	5,428	5,857	6,285
14	3,184	3,673	3,918	4,163	4,408	4,653	5,020	5,387
16	2,785	3,214	3,428	3,643	3,857	4,071	4,393	4,713
18	2,476	2,857	3,047	3,238	3,428	3,619	3,905	4,190
20	2,228	2,571	2,742	2,915	3,086	3,257	3,515	3,771
22	2,025	2,337	2,493	2,649	2,805	2,961	3,195	3,428
24	1,857	2,143	2,285	2,428	2,571	2,715	2,929	3,143
26	1,715	1,977	2,109	2,241	2,373	2,505	2,703	2,901
28	1,592	1,836	1,959	2,081	2,203	2,326	2,510	2,694
29	1,537	1,773	1,891	2,009	2,128	2,246	2,424	2,600
30	1,485	1,713	1,828	1,943	2,057	2,171	2,343	2,513
32	1,393	1,607	1,713	1,821	1,929	2,035	2,196	2,357
34	1,311	1,513	1,613	1,715	1,815	1,916	2,067	2,219
36	1,238	1,428	1,523	1,619	1,714	1,809	1,952	2,095
38	1,173	1,353	1,443	1,533	1,624	1,713	1,849	1,985
40	1,115	1,285	1,371	1,457	1,543	1,628	1,757	1,885
44	1,013	1,169	1,247	1,324	1,403	1,480	1,597	1,715
50	892	1,028	1,097	1,165	1,235	1,303	1,405	1,508

REEDS AND COMBS.

Our improved Expansion Warper Comb gives the best satisfaction to all who use it. We have often furnished them for other makes of warper.

A maximum number of ends in a 54-inch comb can be reduced 20 per cent. by the expansion apparatus. The Reed is formed by attaching a bar over the top of the wires of a comb, which expands or contracts to the same extent.

WE MAKE THREE VARIETIES OF WARPER REEDS OR COMBS.

1st. The front comb, or comb next the beam. This is open on top.

2d. The back comb. This is similar to the front comb, but has in addition a bar placed about 3 inches behind it to hold the ends from the upper half of the creel down between the wires.

3d. The back reed, which has a top-rail directly over and covering the tops of the wires. We make two kinds of back reeds, the "high" and the "low."

The "high" reed measures 5 inches from top of case to underside of hand rail.

The "low" reed measures 3 inches from top of case to underside of top rail.

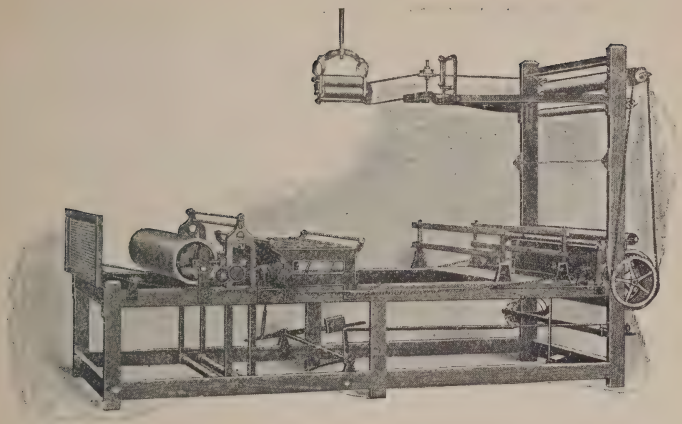
DIRECTIONS FOR ORDERING.

How many front combs	Highest No. ends	Length Cyl.
How many back combs	Highest No. ends	Length Cyl.
How many back reeds	Highest No. ends	Length Cyl.

Our usual length of box for either reeds or combs, is 72 inches; if any other length is wanted please specify.

REMARKS.

Do you have a carrier roll between front comb and beam?.....
Do you have a carrier roll between back reed or comb and the rising or falling roll?.....
Ordered by.....
Ship to.....
Freight or Express.....



THE WALCOTT CHAIN WARPER.

We have been selling this machine for many years, and it is now an established trade standard for producing chains of indefinite length, with anywhere from 500 to 1200 ends. We place our limit at 1200 ends, as we do not believe there is any economy in running more than that number from one creel, in view of the extra time required for banking and tying in spools, and the necessary stops for piecing up, which reduce the amount of production, and increase cost very materially.

The cut is made from our latest machine, with recent improvements, showing the application of our Walmsley stop-motion, which is very successful with this style of warper.

The complete warper and creel for 1200 spools and receiving bag and position for the operator, occupies a space of about sixteen feet by thirty-four feet, with stop-motion; two feet less without. It stands eight and one-half feet high. One of these machines will do more and better work than three circular or upright warpers. This claim is made without distinction of coarse or fine numbers, small or large chains. We can refer to satisfied users as a recommendation, if necessary.

DIMENSIONS OF CREELS FOR WALCOTT CHAIN WARPER.

No. of Ends.	No. Spools High.	No. Spools Long.	7½″ RUN, to carry spools with 3½″ h'd, 4½″ traverse			8″ RUN, to carry spools with 4″ head, 5″ traverse.			8½″ RUN to carry spools with 4″ head, 6″ traverse.			9″ RUN, to carry spools with 5″ head, 6″ traverse.		
			L'gth	Width.	Height	L'gth.	Width.	Height	L'gth.	Width.	Height	L'gth.	Width.	Height.
1200	20	30	17′ 8″	15′ 1″	7′ 4¼″	18′ 9″	16′	8′ 2½″	19′ 11″	16′ 10″	8′ 2½″	21′	17′ 9″	9′ 10½″
1160	20	29	17′ 1″	14′ 8″	7′ 4¼″	18′ 2″	15′ 6″	8′ 2½″	19′ 3″	16′ 4″	8′ 2½″	20′ 4″	17′ 2″	9′ 10½″
1120	20	28	16′ 6″	14′ 2″	7′ 4¼″	17′ 7″	15′	8′ 2½″	18′ 7″	15′ 10″	8′ 2½″	19′ 8″	16′ 8″	9′ 10½″
1080	18	30	17′ 8″	15′ 1″	6′ 8″	18′ 9″	16′	7′ 5″	19′ 11″	16′ 10″	7′ 5″	21′	17′ 9″	8′ 11″
1044	18	29	17′ 1″	14′ 8″	6′ 8″	18′ 2″	15′ 6″	7′ 5″	19′ 3″	16′ 4″	7′ 5″	20′ 4″	17′ 2″	8′ 11″
1008	18	28	16′ 6″	14′ 2″	6′ 8″	17′ 7″	15′	7′ 5″	18′ 7″	15′ 10″	7′ 5″	19′ 8″	16′ 8″	8′ 11″
972	18	27	15′ 11″	13′ 9″	6′ 8″	16′ 11″	14′ 6″	7′ 5″	17′ 11″	15′ 4″	7′ 5″	18′ 11″	16′ 1″	8′ 11″
960	16	30	17′ 8″	15′ 1″	6′ 3½″	18′ 9″	16′	6′ 11½″	19′ 11″	16′ 10″	6′ 11½″	21′	17′ 9″	8′ 3½″
928	16	29	17′ 1″	14′ 8″	6′ 3½″	18′ 2″	15′ 6″	6′ 11½″	19′ 3″	16′ 4″	6′ 11½″	20′ 4″	17′ 2″	8′ 3½″
896	16	28	16′ 6″	14′ 2″	6′ 3½″	17′ 7″	15′	6′ 11½″	18′ 7″	15′ 10″	6′ 11½″	19′ 8″	16′ 8″	8′ 3½″
864	16	27	15′ 11″	13′ 9″	6′ 3½″	16′ 11″	14′ 6″	6′ 11½″	17′ 11″	15′ 4″	6′ 11½″	18′ 11″	16′ 1″	8′ 3½″
840	14	30	17′ 8″	15′ 1″	5′ 6½″	18′ 9″	16′	6′ 1½″	19′ 11″	16′ 10″	6′ 1½″	21′	17′ 9″	7′ 3½″
812	14	29	17′ 1″	14′ 8″	5′ 6½″	18′ 2″	15′ 6″	6′ 1½″	19′ 3″	16′ 4″	6′ 1½″	20′ 4″	17′ 2″	7′ 3½″
784	14	28	16′ 6″	14′ 2″	5′ 6½″	17′ 7″	15′	6′ 1½″	18′ 7″	15′ 10″	6′ 1½″	19′ 8″	16′ 8″	7′ 3½″
756	14	27	15′ 11″	13′ 9″	5′ 6½″	16′ 11″	14′ 6″	6′ 1½″	17′ 11″	15′ 4″	6′ 1½″	18′ 11″	16′ 1″	7′ 3½″
728	14	26	15′ 4″	13′ 3″	5′ 6½″	16′ 3″	14′ 1″	6′ 1½″	17′ 3″	14′ 9″	6′ 1½″	18′ 3″	15′ 6″	7′ 3½″
700	14	25	14′ 9″	12′ 10″	5′ 6½″	15′ 8″	13′ 7″	6′ 1½″	16′ 7″	14′ 3″	6′ 1½″	17′ 6″	15′	7′ 3½″
672	14	24	14′ 2″	12′ 4″	5′ 6½″	15′ 1″	13′ 1″	6′ 1½″	15′ 11″	13′ 9″	6′ 1½″	16′ 10″	14′ 5″	7′ 3½″
644	14	23	13′ 7″	11′ 11″	5′ 6½″	14′ 5″	12′ 7″	6′ 1½″	15′ 3″	13′ 3″	6′ 1½″	16′ 2″	13′ 11″	7′ 3½″
616	14	22	13′	11′ 6″	5′ 6½″	13′ 9″	12′ 1″	6′ 1½″	14′ 7″	12′ 9″	6′ 1½″	15′ 5″	13′ 4″	7′ 3½″
588	14	21	12′ 5″	11′	5′ 6½″	13′ 2″	11′ 7″	6′ 1½″	13′ 11″	12′ 3″	6′ 1½″	14′ 9″	12′ 10″	7′ 3½″

SPECIFICATION FOR WALCOTT CHAIN WARPERS

ORDERED OF THE DRAPER COMPANY, HOPEDALE, MASS.

For.....

.....190

Number of chain warpers with driving pulleys on right hand side.....

Number of chain warpers with driving pulleys on left hand side.....

Number of ends to be run in each warper.....

Number of deliveries for each warper.....

Delivery and operator's position to be at (right or left) hand

Thread lease.....

Pin lease for how many ends in a pin?.....

Number of yarn to be run in each warper.....

Number of yards in each cut.....

Number of cuts in each chain.....

Walmsley stop-motion.....

Number of adjustable V creels (Send sample spool marked with name of mill if creels are wanted).....

Skewer bearings cut in creel stile.....

Creel steps (of iron or glass).....

Ship (in crates or taken down and boxed).....

Do you want Linkers?.....

State distance between floors, as delivery is attached to floor above; or if delivery is to be attached to beams or stringers, state distance from floor up to them.....

Ship via.....

See illustration for arrangement of spools in creels for different numbers of ends, with floor space required for creels with different sizes of spools.

Length of warper frame, 10 feet, with stop-motion, 12 feet.

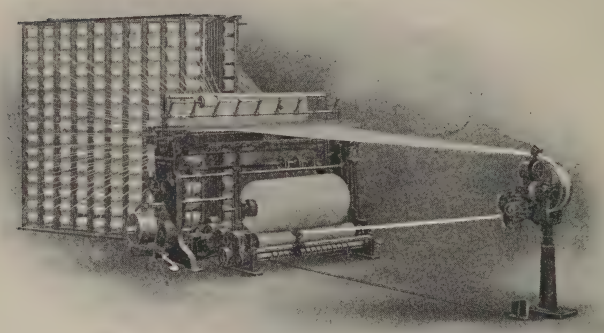
Space between holey board and creel, about 2 feet, 6 inches.

Space between spools in creels, 18 and 20 spools high, ¾ inch; 14 and 16 spools high, 1 inch.

Holey board and lease reeds are 46 inches wide, and made to correspond with number of ends in creel.

If skewers are used they should be 1 1-16 inch longer than spools.

Driving pulley 10 inches in diameter for 2-inch belt.

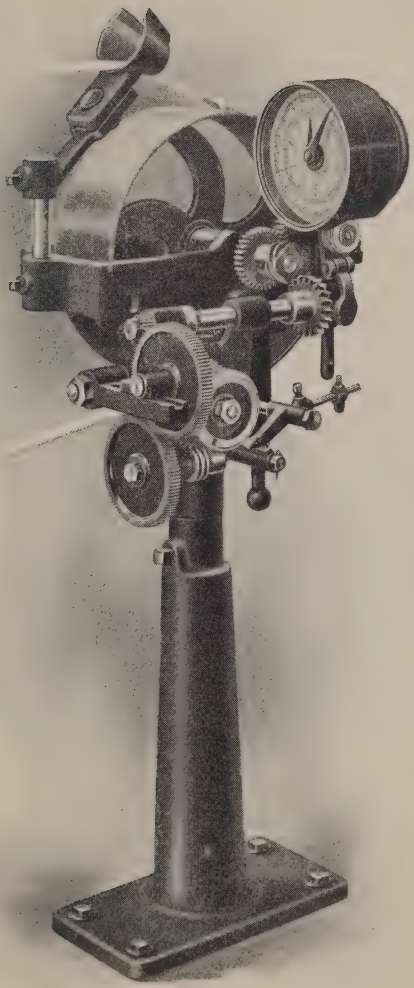


OUR NEW BALLING MACHINE.

We have recently made several quite important improvements in our balling machine, which we have thoroughly tested out in actual practice, before approving of the same as our regular trade standards. There are various methods of making chain warps, some mills preferring to make chains containing a large number of ends; the majority, however, using chains with 500 ends, or less. No one machine will suit both methods.

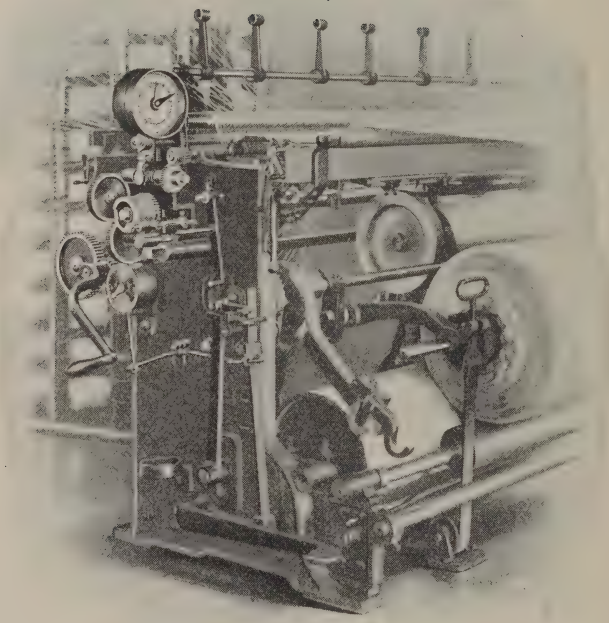
We sell our Walcott warper for chains over 500 ends, but recommend the balling machine for a smaller number. In our second edition of our catalogue, "Textile Texts," we heralded the advent of a four-ball warper which promised well, and the use of this style led to the present improvement. The object of the four-ball warper was to save in waste, as it was difficult to measure four balls on four different machines accurately enough so that all four would run out substantially alike. We have accomplished the same result; that is, ensured the accurate measuring of the chain by a much simpler method, as we now measure direct from the pulley, and as the pulley is of large surface and has practically nothing to do, except guide the chain and rotate the indicator, there is little or no liability for slip.

The cut of the entire machine shows the whole apparatus, the ball being wound on the separate rolls, which give large frictional driving power, and also shows the stopping connection from the pulley back to the machine. The detail of the pulley apparatus is shown more in detail in the separate cut.



BALLING MACHINE PULLEY WITH CLOCK ATTACHED.

Our new clock is meeting with great favor. It is substantial and accurate, stopping the machine at any length of chain desired.



WARPER CLOCK ATTACHED DIRECTLY TO WARPER.

We apply the new clock to our older style of Balling Machine when requested.

We might caution our customers about the use of yarn for either balling machines or warpers that is made into a heavy spool load, unless special pains are taken to ensure ease of rotation at the creel. Where a large number of heavy spools are used, it requires a very appreciable pull to start them in rotation, and every possible means of lessening friction should be adopted.

SPECIFICATIONS FOR RHOADES PATENT REGISTER FOR WARPERS

ORDERED FROM THE DRAPER COMPANY, HOPEDALE, MASS.

Ordered by..... Date.....
Address.....
How many Registers?.....
For what make of Warper?.....
Rise or Drop Roll?.....
Diameter of Cylinder?.....
Right or Left Hand Warper?.....
Circumference of Measuring Roll if any?.....
When were Warpers purchased?.....
What number of yards do you wish registered?.....
What number of yards per wrap of clock now on warper?.....
Is Warper run with Balling Machine?.....
Do we apply?.....
How ship?.....

SPECIFICATIONS OF BALLING MACHINES AND LEASING MOTIONS

ORDERED FROM THE DRAPER COMPANY, HOPEDALE, MASS.

For..... Date..... 190.....
How many for Right Hand Warper.....
How many for Left Hand Warper.....
How many Balls to be wound on one machine, (One or Two)
What Model of machine.....
How many Balls to be wound on one machine, (One or Two).....
What Model of machine.....
What length of Traverse, (Regular size 30 inches).....
How many Wood Rolls..... Shell or Solid.....
Clock to stop every..... yards.....
Register to register up to..... yards.....
How many Leasing Motions Right Hand.....
How many Leasing Motions Left Hand.....
How many Ends..... on..... inches
What make of Warper is Balling machine to be applied to.....
Length of Cylinder.....
Diameter of Cylinder.....
Diameter of Measuring Roll.....
Diameter of Measuring Roll Shaft for Clock Worm.....
Distance between Ribs of Warper Sides.....
Diameter of Beam Arm Girt.....
Diameter of Cylinder Gear.....
No. of Teeth in Cylinder Gear.....
Distance between Cylinder Gear and Warper Side.....
☞ In sending samples, please specify where from.....

TO FIGURE CALCULATION WEIGHT OF CHAINS.

No. Yarn.	Constant.	No. Yarn.	Constant.	No. Yarn.	Constant.
1	11.904762	35	.34	69	.1725
2	5.952	36	.3307	70	.17
3	3.968	37	.3218	71	.1677
4	2.976	38	.3133	72	.1654
5	2.3808	39	.3053	73	.1631
6	1.984	40	.2976	74	.1609
7	1.7006	41	.2904	75	.1587
8	1.488	42	.2835	76	.1567
9	1.3228	43	.2769	77	.1546
10	1.19	44	.2706	78	.1526
11	1.0822	45	.2645	79	.1507
12	.992	46	.2588	80	.1488
13	.9158	47	.2533	81	.147
14	.8503	48	.248	82	.1452
15	.5736	49	.2429	83	.1434
16	.744	50	.238	84	.1417
17	.7003	51	.2334	85	.14
18	.6614	52	.229	86	.1384
19	.6265	53	.2246	87	.1368
20	.5952	54	.2205	88	.1353
21	.5669	55	.2164	89	.1338
22	.5411	56	.2126	90	.1323
23	.5176	57	.2089	91	.1308
24	.496	58	.2053	92	.1294
25	.4761	59	.2018	93	.128
26	.4579	60	.1984	94	.1267
27	.4409	61	.1951	95	.1253
28	.4252	62	.192	96	.124
29	.4105	63	.189	97	.1227
30	.3968	64	.186	98	.1215
31	.384	65	.1832	99	.1203
32	.372	66	.1804	100	.119
33	.3608	67	.1777		
34	.3501	68	.1751		

TO FIGURE CONSTANT—Divide 11.904762 by the No. of yarn equals the constant.

RULE—Point off two places in the ends and yards, or four places in the yards; multiply one by the other and the result by the constant.

EXAMPLE—Calculation weight of a chain of 400 ends of No. 24 yarn 5000 yards in length. (24—400—5000 yards.)

50.00 .496—constant for No. 24 yarn.
4.00 200

200.0000 99.200 Lbs. Answer.

PROOF—840×24=20160 yds. to lb÷400=50.4 yds. to lb. of 400 ends. 5000÷50.4=99.2 lbs.

The above table was kindly furnished us by Mr. John S. Adams, Jr., of Adams, Mass.

Change Gears for Balling Machine Clock.

This sheet to be used with Rhoades' Clocks on all models of Warpers.

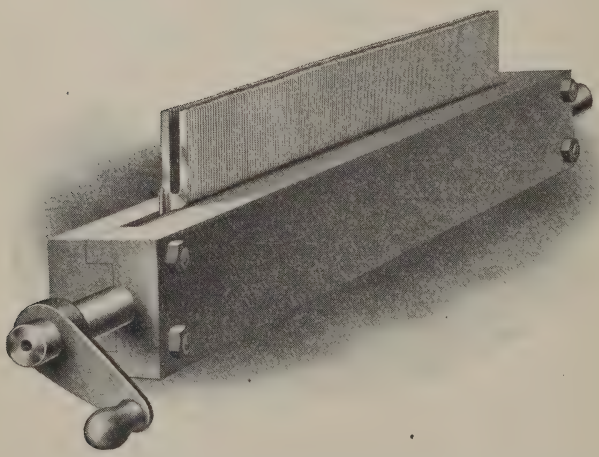
Yards per Lease.	Top Gear.	Bottom Gear.	No. of Raps.	Yards per Lease.	Top Gear.	Bottom Gear.	No. of Raps.	Yards per Lease.	Top Gear.	Bottom Gear.	No. of Raps.	Yards per Lease.	Top Gear.	Bottom Gear.	No. of Raps.	Yards per Lease.	Top Gear.	Bottom Gear.	No. of Raps.	Yards per Lease.	Top Gear.	Bottom Gear.	No. of Raps.
20	100	20	1	74	100	37	2	141	100	47	3	220	30	66	1	308	25	77	1	408	100	68	6
21	100	21	1	75	100	25	3	142	50	71	1	222	100	37	6	310	30	93	1	410	20	82	1
22	100	22	1	76	100	38	2	144	50	72	1	224	50	56	2	312	25	78	1	413	100	59	7
23	100	23	1	77	100	77	1	145	40	58	1	225	32	72	1	315	100	63	5	414	100	69	6
24	100	24	1	78	100	39	2	146	50	73	1	228	50	57	2	316	25	79	1	415	20	83	1
25	100	25	1	79	100	79	1	147	100	49	3	230	30	69	1	318	100	53	6	416	100	52	8
26	100	26	1	80	100	40	2	148	50	74	1	231	100	77	3	320	25	80	1	420	20	84	1
27	100	27	1	81	100	81	1	150	40	60	1	232	50	58	2	322	100	46	7	423	100	47	9
28	100	28	1	82	100	82	1	152	50	76	1	234	100	78	3	324	25	81	1	424	100	53	8
29	100	29	1	83	100	83	1	153	100	51	3	235	100	47	5	325	24	78	1	425	20	85	1
30	100	30	1	84	50	42	1	154	50	77	1	236	50	59	2	328	25	82	1	427	100	61	7
31	100	31	1	85	100	85	1	155	40	62	1	237	100	79	3	330	30	99	1	430	20	86	1
32	100	32	1	86	50	43	1	156	50	78	1	240	30	72	1	332	25	83	1	432	100	72	6
33	100	33	1	87	100	29	3	158	50	79	1	243	100	81	3	333	100	37	9	435	20	87	1
34	100	34	1	88	50	44	1	159	100	53	3	244	50	61	2	335	100	67	5	438	100	73	6
35	100	35	1	89	100	89	1	160	40	64	1	245	100	49	5	336	25	84	1	440	20	88	1
36	100	36	1	90	50	45	1	161	100	23	7	246	100	82	3	340	25	85	1	441	100	49	9
37	100	37	1	91	100	91	1	162	50	81	1	248	50	62	2	342	100	57	6	444	100	74	6
38	100	38	1	92	50	46	1	164	50	82	1	249	100	83	3	343	100	49	7	445	20	89	1
39	100	39	1	93	100	31	3	165	40	66	1	250	30	75	1	344	25	86	1	448	100	56	8
40	100	40	1	94	50	47	1	166	50	83	1	252	50	63	2	345	100	69	5	450	20	90	1
41	100	41	1	95	60	57	1	168	50	84	1	255	100	51	5	348	100	58	6	455	20	91	1
42	100	42	1	96	50	48	1	170	40	68	1	256	50	64	2	350	24	84	1	456	100	76	6
43	100	43	1	97	100	97	1	172	50	86	1	258	100	86	3	351	100	39	9	459	100	51	9
44	100	22	2	98	50	49	1	174	50	87	1	259	100	37	7	352	25	88	1	460	20	92	1
45	100	45	1	99	100	99	1	175	40	70	1	260	30	78	1	354	100	59	6	462	100	77	6
46	100	23	2	100	50	50	1	176	50	88	1	261	100	87	3	355	100	71	5	464	100	58	8
47	100	47	1	102	50	51	1	178	50	89	1	264	50	66	2	356	25	89	1	465	20	93	1
48	100	24	2	104	50	52	1	180	40	72	1	265	100	53	5	357	100	51	7	468	100	78	6
49	100	49	1	105	60	63	1	182	50	91	1	267	100	89	3	360	25	90	1	469	100	67	7
50	100	25	2	106	50	53	1	183	100	61	3	268	25	67	1	364	25	91	1	470	20	94	1
51	100	51	1	108	50	54	1	184	50	92	1	270	30	81	1	365	20	73	1	472	100	59	8
52	100	26	2	110	50	55	1	185	40	74	1	272	25	68	1	366	100	61	6	474	100	79	6
53	100	53	1	111	100	37	3	186	100	62	3	273	100	39	7	368	25	92	1	475	20	95	1
54	100	27	2	112	50	56	1	188	50	47	2	275	24	66	1	369	100	41	9	477	100	53	9
55	100	55	1	114	50	57	1	189	100	27	7	276	25	69	1	370	20	74	1	480	100	80	6
56	100	28	2	115	40	46	1	190	40	76	1	279	100	31	9	371	100	53	7	483	100	69	7
57	100	57	1	116	50	58	1	192	50	96	1	280	25	70	1	372	25	93	1	485	20	97	1
58	100	29	2	118	50	59	1	195	40	78	1	282	100	47	6	375	24	90	1	486	100	81	6
59	100	59	1	120	45	54	1	196	50	98	1	284	25	71	1	376	25	94	1	488	100	61	8
60	100	30	2	122	50	61	1	198	50	99	1	285	100	57	5	378	100	63	6	490	20	98	1
61	100	61	1	123	100	41	3	200	50	100	1	287	100	41	7	380	20	76	1	492	100	82	6
62	100	31	2	124	50	62	1	201	100	67	3	288	25	72	1	384	25	96	1	495	20	99	1
63	100	63	1	125	48	60	1	203	100	29	7	290	30	87	1	385	100	55	7	496	100	62	8
64	100	32	2	126	50	63	1	204	50	51	2	291	100	97	3	387	100	43	9	497	100	71	7
65	100	65	1	128	50	64	1	205	40	82	1	292	25	73	1	388	25	97	1	498	100	83	6
66	100	33	2	129	100	43	3	207	100	69	3	294	50	49	3	390	20	78	1	500	20	100	1
67	100	67	1	130	50	65	1	208	50	52	2	295	100	59	5	392	25	98	1				
68	100	34	2	132	50	66	1	210	30	63	1	296	25	74	1	395	20	79	1				
69	100	23	3	134	50	67	1	212	50	53	2	297	100	99	3	396	25	99	1				
70	100	35	2	135	40	54	1	215	100	43	5	300	25	75	1	399	100	57	7				
71	100	71	1	136	50	68	1	216	50	54	2	304	25	76	1	400	20	80	1				
72	100	36	2	138	50	69	1	217	100	31	7	305	100	61	5	405	20	81	1				
73	100	73	1	140	40	56	1	219	100	73	3	306	100	51	6	406	100	58	7				

IMPROVED CUT-MARKERS FOR SLASHERS.

The Rolfe Cut-Marker has been in use a number of years, and has given good satisfaction. Its motion is positively obtained by gearing, without wire or springs. It does not waste or splash the marking ink, and is liked by all who use it. It marks the wet yarn between the size box and drying cylinder; the mark is therefore dried in with the sizing, and can neither be rubbed off or transferred to other layers of yarn on the beam. The mark is neat and well defined, and cannot be used as an excuse for making short cuts.

Send for prices.

THE RHOADES PATENT DOUBLE-DENT SLASHER COMB.



We have recently started to introduce the Rhoades patent Slasher Comb shown in the illustration, and are having a marked success, the advantages being readily appreciated wherever the device is shown. This comb gives twice the separation of the ordinary comb by use of the double-prong offset dents preventing the threads from sticking, rolling over and crossing. It is especially applicable to stripes and colored work; also for yarns requiring a thin dent at present. The improvement is of course made manifest in the weave-room, where the smoother beams weave off much better, causing less warp-breaks, less hitch-backs and less uneven work.

SPECIFICATIONS FOR PATENT SLASHER COMBS

ORDERED FROM DRAPER COMPANY,

HOPEDALE, MASS.

Ordered by ..... Date .....

Address .....

How many Slasher Combs? .....

How many Dents in each? .....

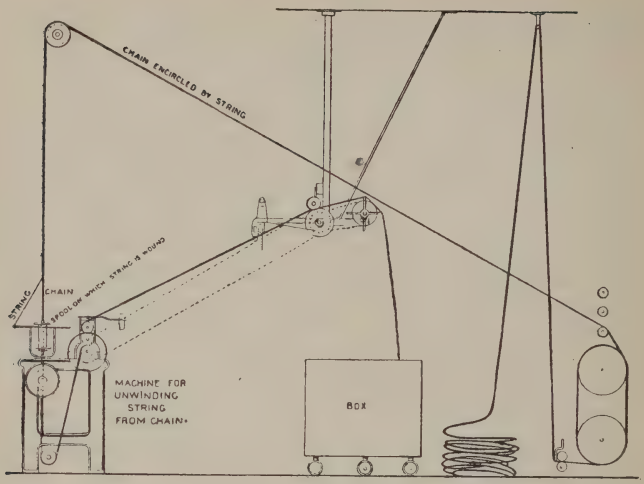
How many inches are Dents to be spread on when Comb is contracted? .....

How many inches are Dents to be spread on when Comb is expanded? .....

Length of Comb Case? .....

The length of the Comb Case must be at least 10″ more than the greatest expansion.

Length of Comb from end to end of Gudgeons? .....



A NEW PROCESS IN CHAIN DYEING.

All manufacturers of colored goods, the yarns for which are bleached or dyed before using, are only too familiar with the constant annoyance and expense caused by the snarling and breaking of the yarn in the various processes of the dye house.

Since the introduction of chain quilling machines, by far the largest part of cotton yarns, both warp and filling, have been colored in the chain, which, notwithstanding all its drawbacks, has been found on the whole the most economical method.

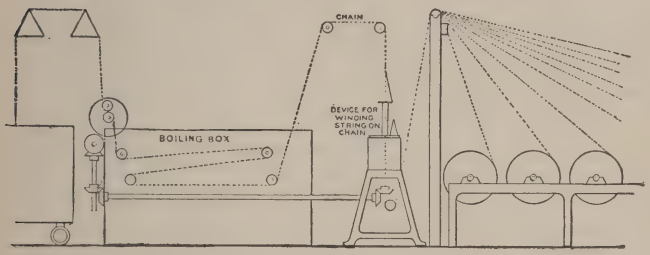
The most difficult and unsatisfactory process in all manufacturing has hitherto been the rewinding or beaming of the colored or bleached chains after they are returned from the dye house.

No one familiar with the manufacture of colored goods needs to be reminded of the endless number of broken and snarled chains, slack threads and twisted selvages, which are continually turning up in the beaming room, however carefully the dye house is managed.

There has long been an urgent need for some process or method by which the excessive damage done to chains in the dye house might be avoided, and the following processes of manufacture be thus rendered less difficult.

This need has at length been supplied, and we are prepared to furnish methods and machines by the use of which the snarling and breaking of chains in the dye house can be practically prevented.

Several years ago a Mr. Henry Gildard, employed at the time in one of our large colored mills, conceived the idea of winding or coiling around each chain from end to end a cord of suitable strength to hold the various threads together and prevent snarling and breaking in the dye house. The patents taken out by him are in our hands, together with supplementary patents by Mr. Herman F. Straw of the Amoskeag Mfg. Co., covering mechanical methods of unwinding the cord from the chain.



This system of chain dyeing, including both the winding and unwinding process, is already in use by the principal mills that use colored warps, so that the field for further sales is somewhat limited.

The sketches we show in rough detail may help to give an idea of how the machines are used.

We have seldom introduced an idea that won so prompt a recognition and gave so large a return on the capital invested. It certainly ranks with the most important of recent textile inventions.

Any one wishing to investigate this process, would do well to communicate with us, and we can send our expert to talk the matter over with them.

We believe we are well within bounds when we say that a net saving of **at least one-half the whole cost of rebeaming** may readily be made in the dressing room alone, and the gain in the weaving rooms, from the greatly improved preparation and the absence of knots and twists, should be nearly as much more.

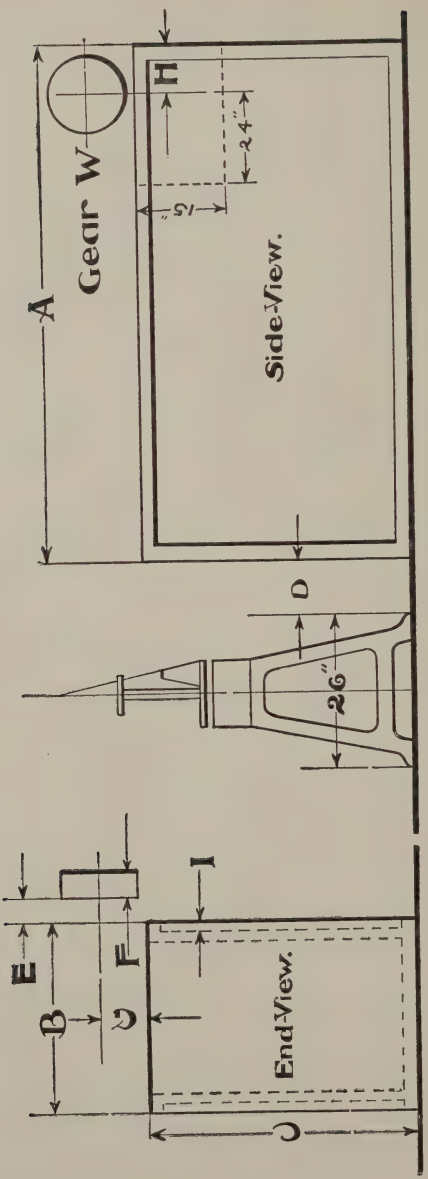


Diagram for Specification.

SPECIFICATIONS FOR STRAW'S PATENT WINDING AND UNWINDING MACHINES

ORDERED FROM DRAPER COMPANY, HOPEDALE, MASS.

Ordered by.....Date.....
Address.....
Number of Winding Machines .....Spindles each.....
Number of Unwinding Machines.....
Number of Boiling Boxes.....Maker of Boiling Boxes.....
Is Box Wood or Iron?.....If Wood, has it an Iron Frame?.....
Are there any projections or irregularities on the side of the box under Gear W within the space included by the dotted lines?.....If so, give sketch locating them. Is Gear W a Bevel Gear?.....If so, give number of teeth in other gear meshing with it, and sketch showing size and location of shaft it goes on.
In case space under Gear W is taken up by some mechanism and similar space on opposite side of box is clear, and shaft carrying Gear W extends beyond bearing, give drawing of shaft and distance from side of box from which the gear may be located on the shaft.
Circumference of Drawing Roll .....
Number of teeth in Gear W .....Outside Diameter of Gear W....
NOTE. In case Gear W is not on the same shaft as the Drawing Roll, give number of revolutions of Gear W to one revolution of Drawing Roll.
Looking from the Winding machine is Gear W on the right hand side (as in sketch) or left hand side of Boiling Box?
Give distance at A.....B.....C.....D.....
E.....F.....G.....H.....
Give depth of Rib I, if Box has a Rib.....

THE HOPEDALE TWISTER.

Our well known Twister, is still of the heavy and substantial pattern which has met with the strong approval of our customers. It has been our aim in this line, to produce a machine that, while sold at a reasonable price should have so many elements of superiority that good judgment must necessarily determine its selection. We call attention to the various points of superiority, and only ask for investigation as to the truth of our claims.

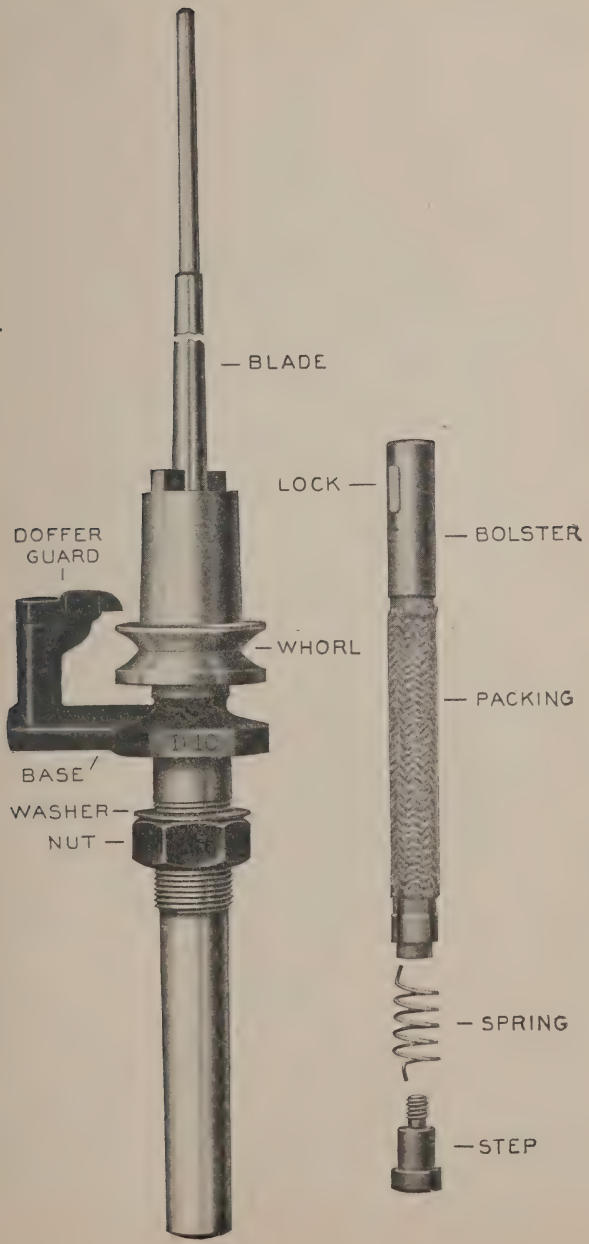
In paying for a machine constructed of iron and steel, it would seem more or less essential to know how much of **quantity** one was receiving, especially when the **quality** cannot be criticised. **We invite comparison of weights** with any twister made. We believe high-speed machinery should be solid and properly proportioned, especially as the present trend of invention may produce devices which will enable much higher speed.

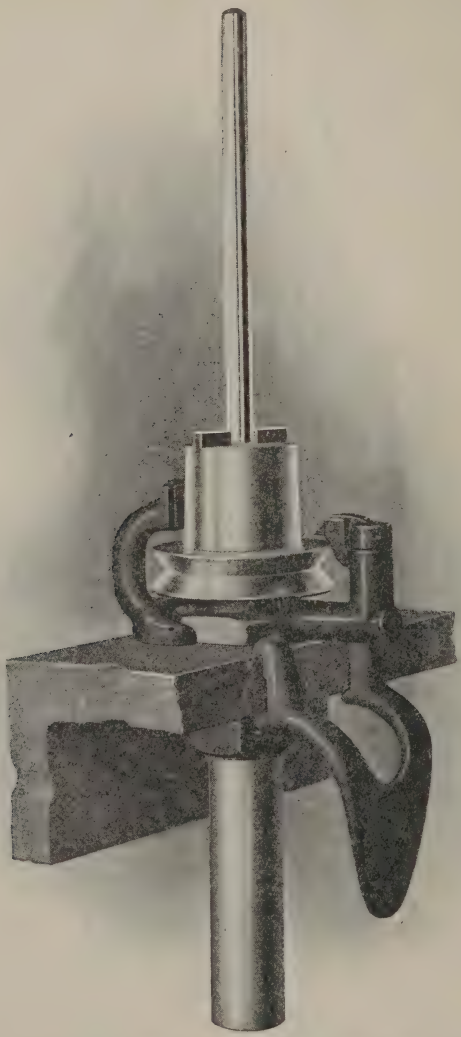
Starting at the head end, our **Neat Covers** must certainly attract attention. They are removable without the operation of removing bolts or screws, being held in place by **Automatic Locking Devices.**

Our **Spindle Rails** are of **Heavy Box Pattern** and **the Samsons have Adjustable Legs** to accommodate any variation in the floor level. The adjustment is positive and capable of most accurate screw and nut setting.

Some time ago we adopted the **Taper Bearing** and **Screw Step** for our twister spindles, as used so long and with such great success, on our spinning spindles. Their introduction however, introduced a difficulty not common on the smaller type, as the pins which locked the step and bolster sometimes got loose, providing the step or bolster were jammed down on them with the slots out of line. In our latest construction, **we use no pins** and therefore drill no holes through the base, thus avoiding all leakage.

The bolster is **locked by a spline,** as seen in the cut, which holds in a slot, and the step is held in place by a spring connection which can be easily changed in position for adjustment of the bearing fit. The spring has no function as such while the spindle is running. We have thousands of these spindles already in use, giving excellent satisfaction.

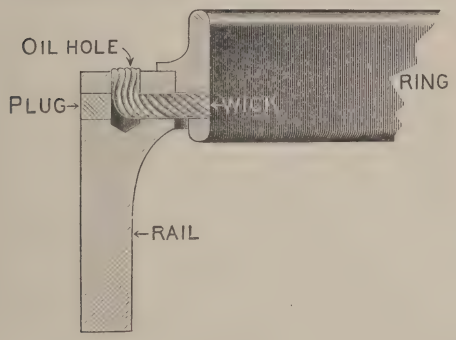

— BLADE
LOCK —
— BOLSTER
DOFFER GUARD
— WHORL
— PACKING
BASE
WASHER —
NUT —
— SPRING
— STEP



Our **Spindle Brake** is another neat idea, which is extensively copied now that the patent has expired. It is essential on large, heavy spindles. The brake is a simple casting, with knee plate, extension to rest on rail, and leather friction pad which applies the brake pressure and which also overhangs the whorl thus serving as a spindle retainer. By simply tilting the casting, the spindle can be removed or raised. Nothing could be simpler.

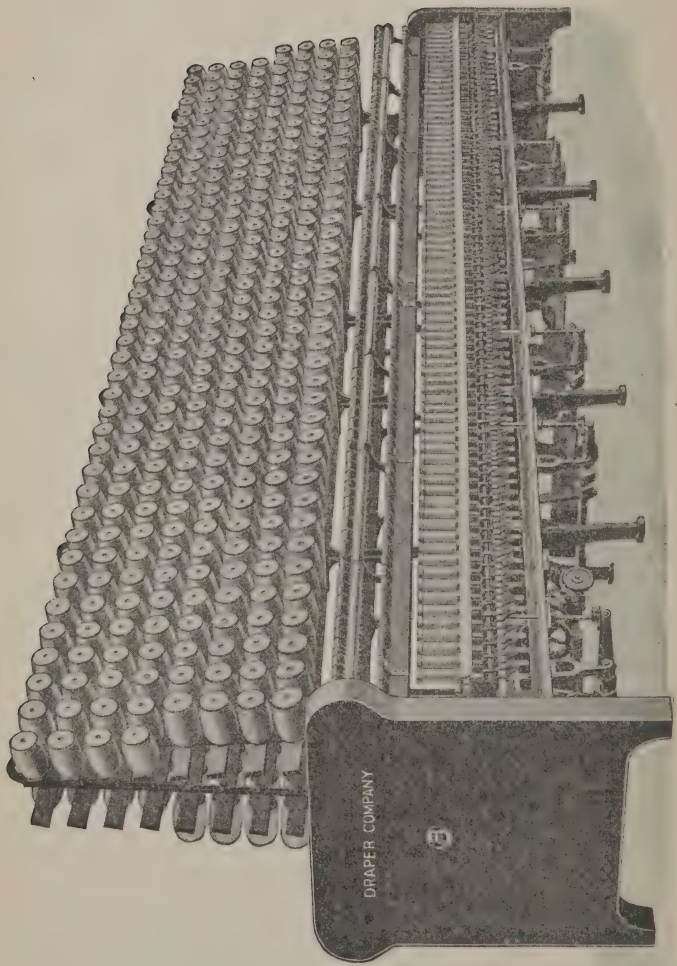
Our **Rings** are all of our own manufacture and we can recommend them in every particular. While furnishing all the standard styles, we have certain novelties of our own which are exclusively used on our machines.

CARTER OILING DEVICE
FOR VERTICAL TWISTER RINGS.

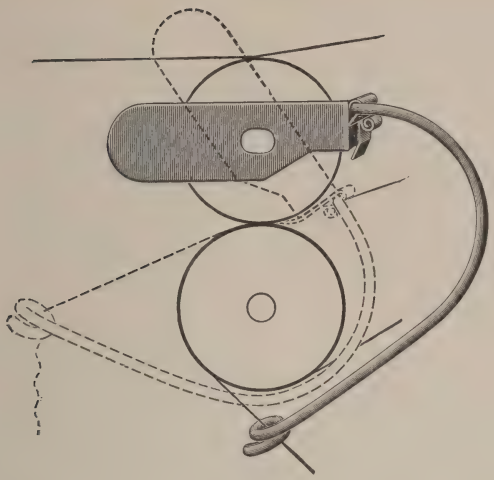


The **Carter Self-Oiling Ring** is recommended for vertical rings of three inches in diameter or more. The invention consists in the application of a wick, which lubricates the traveller below its contact with the yarn, allowing the speed to be increased from 15 to 25 per cent.

The T. H. Smith Patent Twister Stop-Motion.—In spite of efforts of dozens of inventors, there has never been but one successful twister stop-motion and that is the type shown in the illustration on page 233. The cut is self-explanatory, as the device consists simply of a bent wire attached to a sheet metal holder, having a hole or bearing to encircle the top-roll pivot, and a flexible metallic (German silver) tongue to engage the top-roll and stop its rotation, when the breakage or slackening of the thread allows the overweighted structure to feed the tongue in between the rolls. Its use prevents roller laps, enables the help to tend more spindles, practically stops all waste and allows the speed to be increased.



The Hopedale Twister.



A Recent Improvement consists in extending the rear portion of the signal so that it will stick up prominently and attract the eye of the operative when an end is broken. This idea was suggested to us by Mr. David Clark of the Ada Mfg. Company, and patented in his name.

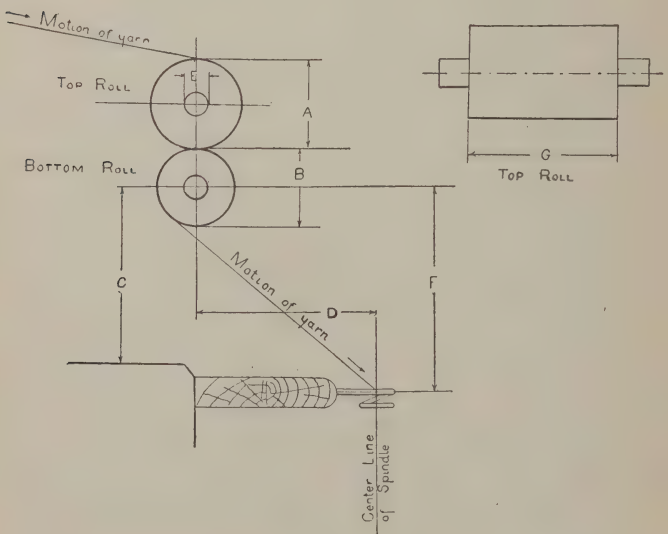
While we have equipped a fair proportion of the twisting mills with this device, there are many still running that might profit by its use. Understand, however, that we do not claim that it is suitable for all conditions. It is **not** recommended for wet twisting. It only applies when a single line of rolls is used, with yarn delivered from the under side of the bottom roll. Used with two-ply yarn it will stop delivery if either thread breaks. With more than two-ply, it only stops when the formed twisted thread breaks. If a band breaks on a spindle, the stop-motion will hold the end until a new band is put on. Broken ends are held in place and do not lash around to break others. The frame can be started after doffing without stopping to piece up.

One user who was short of help ran his twisters without attempting to piece up the ends as the stop-motion could take care of broken ends. In this way the doffers practically ran the frames.

We supply the devices to builders of other frames, and to old twisters already in the mills, besides adopting it for our own new twisters whenever ordered. The device is of more value for worsted than cotton, on account of the higher value of the waste saved. The Washington Mills alone have ordered over 20,000 of them at different periods. Saving of waste at

the twister is important, for such waste cannot be re-spun. Using this attachment a twister will run better and make less waste, using single end spools from the common spooler, than from spools wound by the expensive double process on a stop-motion spooler. In one mill, a single twister of 180 spindles, equipped with this stop-motion on worsteds, saved ten ounces per week of waste per spindle, worth 75 cents per pound. On 3,840 twister spindles, on cotton, the average saving in waste per week was 34 pounds. They also saved 17 pounds of sweeps, and paid less per side, per day, for attendance. Even on this small number of spindles, the saving per year was thus figured at $489.

Surely a small trial order could be risked without chance of great loss; in fact, if anyone can point out any possibility of loss, we should be glad to consider their basis of argument.



SPECIFICATIONS FOR SMITH'S PATENT STOP-MOTIONS FOR TWISTERS

ORDERED OF DRAPER COMPANY, HOPEDALE, MASS.

Date..... .....19.....

By.....

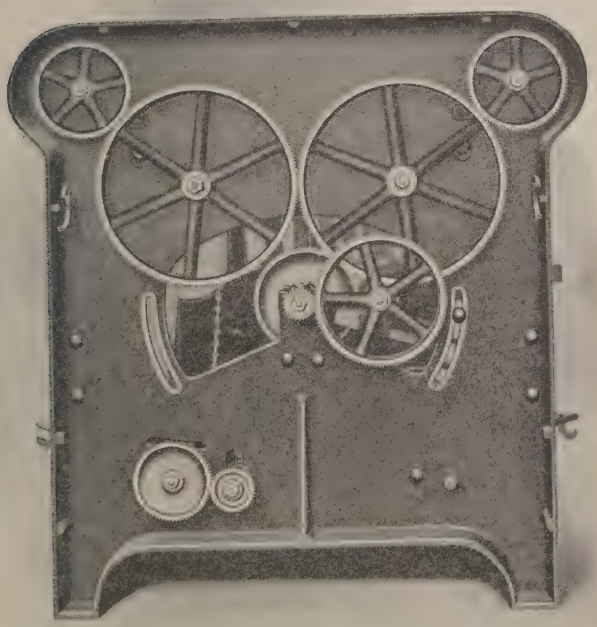
Ship to.....

Number of twisters to have Smith Stop-Motion.....

Number of spindles per twister.....

Builder of twisters.....

Diameter of Top roll (A).....Inches.
Diameter of bottom roll (B)..... "
Top of roller beam to center of bottom roll (C)..... "
Center of bottom roll to center line of spindle (D)..... "
Diam. of top roll gudgeon (E)..... "
Center of bottom roll to center of guide wire (F)..... "
Face of top roll (G)..... "
For Cotton or Worsted yarns?.....
Wet or dry twist?.....
The Smith Stop-Motion is not recommended for wet Twisting.



We arrange our **Twist Gear** directly on the end of the cylinder shaft. With this arrangement the range is greater with less changes and we get less noise. Every gear is **machine cut.** Nothing is more simple or convenient for change.

Our **Traverse Motion** is fitted for **Change Gears,** so that the speed can be accommodated to the conditions, preventing the thread from winding under or piling on the bobbin. More yarn can be wound on a bobbin if attention is given to proper regulation of the traverse speed. We use a simple **Lever Clutch** to throw the worm of our traverse motion out of gear, so that **the Ring Rail may be lowered at any time** when necessary.

TABLE OF TWIST GEARS FOR DRAPER COMPANY'S TWISTER.

This table gives the number of teeth required in cylinder gears with a given stud gear to produce a theoretical twist with 8-inch cylinder and ½-inch band. No allowance is made for contraction.

Diameter of whirl . . .	2½	2¼	1¾	1¼	1⅛	1	⅞
Teeth in stud gear . . .	36	32	36	38	32	28	26
Teeth in cylinder gear.	TWIST.						
18	10.95	13.61	15.33	19.80	25.86	32.85	39.79
19	10.37	12.90	14.52	18.77	24.50	31.12	37.54
20	9.85	12.25	13.79	17.82	23.28	29.56	35.81
21	9.38	11.67	13.14	16.97	22.17	28.15	34.11
22	8.95	11.14	12.54	16.20	21.16	26.87	32.55
23	8.57	10.65	11.99	15.50	20.24	25.70	31.14
24	8.21	10.21	11.49	14.85	19.40	24.63	29.84
25	7.88	9.80	11.03	14.25	18.62	23.65	28.65
26	7.58	9.42	10.61	13.70	17.90	22.74	27.55
27	7.30	9.07	10.22	13.19	17.24	21.90	26.53
28	7.04	8.75	9.85	12.71	16.63	21.12	25.58
29	6.79	8.45	9.52	12.29	16.05	20.39	24.70
30	6.57	8.17	9.20	11.88	15.52	19.70	23.87
31	6.36	7.90	8.90	11.50	15.02	19.06	23.10
32	6.16	7.66	8.62	11.14	14.55	18.47	22.38
33	5.97	7.42	8.36	10.80	14.11	17.91	21.70
34	5.80	7.21	8.11	10.48	13.69	17.38	21.06
35	5.63	7.00	7.88	10.18	13.30	16.89	20.46
36	5.47	6.81	7.66	9.90	12.93	16.42	19.89
37	5.33	6.62	7.45	9.63	12.58	15.98	19.36
38	5.19	6.45	7.26	9.38	12.25	15.56	18.85
39	5.06	6.28	7.08	9.14	11.94	15.16	18.36
40	4.93	6.13	6.90	8.91	11.64	14.78	17.90
41	4.81	5.98	6.73	8.69	11.35	14.42	17.47
42	4.69	5.83	6.57	8.48	11.08	14.07	17.05
43	4.58	5.70	6.42	8.29	10.83	13.75	16.66
44	4.48	5.57	6.27	8.10	10.58	13.44	16.28
45	4.38	5.44	6.13	7.94	10.35	13.14	15.92
46	4.29	5.33	6.00	7.75	10.12	12.86	15.57
47	4.20	5.21	5.87	7.58	9.90	12.58	15.24
48	4.11	5.10	5.75	7.42	9.70	12.32	14.92
49	4.02	5.00	5.63	7.28	9.50	12.07	14.62
50	3.94	4.90	5.52	7.13	9.31	11.82	14.32
51	3.87	4.80	5.41	6.98	9.13	11.59	14.04
52	3.79	4.71	5.31	6.85	8.95	11.37	13.77

This table is figured for 1 1-2 inch bottom roll, with a 90 tooth gear on the front roll, and a 120 tooth jack gear.

The ordinary ranges of twist required are given in the table. If any twist not given is necessary it can be obtained within a small fraction of a turn, by changing both stud and cylinder gears. All gears are interchangeable, and have same size nut, requiring but one size of wrench to make any change.

SPECIFICATIONS OF TWISTERS
Ordered From Draper Company, Hopedale, Mass.

Name ..... Date ..... 19....

Place ....

Ship to ..... Via what route .....

How many Wet Twisters? ..... How many Dry Twisters? .....

How many Spindles in each? ..... Are brakes required on Spindles? .....

What pattern of Spindle? (Draper, Whitin, Sawyer, etc.) .....

If matching a present lot, send sample bobbin and spindle to ensure duplication.

Single or double Boss Top Rolls? ..... Single or double Line Bottom Rolls? .....

What Gauge? ..... Single or double Line Top Rolls?

Kind of Ring? ..... (Vertical or flat-top.) ..... Size of Ring? .....

Is Carter Oiling Device desired on Vertical Rings? (Extra charge for this.) .....

Used only on 3 inch and over.

What length traverse? .....

Will you have Warp, Filling, or Combination wind? .....

Will you have Single or Double-headed bobbin? .....

What number yarn will you twist? ..... How many ply? .....

For how many turns twist per inch shall Twisters be geared?

We furnish three twist gears and charge extra if more are ordered.

Will you twist from beams or spools? .....

If you twist from spool, send sample that you twist from .....

How belted, from Above or Below? .....

Do you want T. H. Smith Stop-Motion? (Recommended especially for two-ply and Dry Twisting only. Extra charge.) .....

Do you want Wire Board Lifters? .....

Cylinders on new pattern Twisters, unless otherwise specified, are 8 inches diameter .....

What size Pulleys, diameter? ..... Face? .....

Pulleys run from 8 to 20 inches, rising by half inches, 2 1-4 to 4 1-4 inch faces.

Is a narrower width than our regular size Twister required? (See back.) .....

Shall Machines be Crated, Shod, or taken down and Boxed? .....

.....

.....

REMARKS .....

.....

☞ We recommend 12 inch or *larger* pulleys.

In sending Spools, please specify on same where from.

DIMENSION OF TWISTERS.

These are figured for 2½ inch pulleys. If other width pulleys are ordered, add to these figures for length, twice the extra width of a pulley.
Example—with 3 3-4 inch pulleys, add 3 inches.

Size of Ring	1¾ in.	2 in.	2¼ in.	2½ in.	3 in.	3½ in.	4 in.	4½ in.
Space between centres of spindles, or guage	2⅔ in.	3 in.	3¼ in.	3½ in.	4 in.	4½ in.	5 in.	5½ in.
* Total width	3 ft. 3½ in.	3 ft. 3¾ in.	3 ft. 4 in.	3 ft. 4¼ in.	3 ft. 4¾ in.	3 ft. 5¼ in.	3 ft. 5¾ in.	3 ft. 6⅜ in.
Approximate weight per spindle in pounds	31	33	36	39	43	46	51	54

Number of Spindles.	LENGTH OF TWISTERS OVER ALL, IN FEET AND INCHES.							
240	29 6	32 0						
220	27 2¼	29 6	31 9½					
200	24 11	27 0	29 1	31 2				
180	22 7½	24 6	26 4½	28 3	32 0			
160	20 4	22 0	23 8	25 4	28 8	32 0		
144	18 6	20 0	21 6	23 0	26 0	29 0	32 0	
140	18 0½	19 6	20 11½	22 5	25 4	28 3	31 2	
128	16 8	18 0	19 4	20 8	23 4	26 0	28 8	31 4
120	15 9	17 0	18 3	19 6	22 0	24 6	27 0	29 6
112	14 10	16 0	17 2	18 4	20 8	23 0	25 4	27 8
108	14 4½	15 6	16 7½	17 9	20 0	22 3	24 6	26 9
100	13 5½	14 6	15 6½	16 7	18 8	20 9	22 10	24 11
96	.....	14 0	15 0	16 0	18 0	20 0	22 0	24 0
90	.....	.....	14 2¼	15 1½	17 0	18 10½	20 9	22 7½
84	.....	.....	.....	14 3	16 0	17 9	19 6	21 3
80	.....	.....	.....	13 8	15 4	17 0	18 8	20 4
72	.....	.....	.....	.....	14 0	15 6	17 0	18 6
64	.....	.....	.....	.....	.....	14 0	15 4	16 8

To ascertain the length of Twister, with any number of spindles: Multiply one-half the number of spindles by the distance between centres of spindles, add 24, and divide by 12; the quotient and remainder will be the total length in feet and inches.

Diameter of driving pulleys 8 to 20 inches, with 2 1-4-inch face. Cylinders are 8 inches in diameter unless otherwise specified.

* Width of Twister on floor 3 feet, 2 inches; the ring rails project beyond other parts, making total width as given above for all sizes at ring rail. The width of head end on level with front roll is 3 feet, 7 3-4 inches. This is the regular width. We make others to order when specified.

Production of Twisters.

In preparing tables of production of our twisters, we have assumed the number of yarn after twisting to be one-half for 2-ply, and one-fourth for 4-ply, of the number before twisting; the twist is indicated by the number at the head of table by which the square root of the twisted yarn is multiplied. (See twist tables 88-92.) The figures given cover the most common sizes of ring and numbers of yarn. What we consider to be a fair allowance for loss by all causes from the theoretical production has been made.

While tables published by other parties give higher figures, they often fail to appreciate the practical limits enforced by the ring and traveler. **Our Twisters will give as large a product as any,** but we do not care to make excessive claims which cannot be carried out by the average user. In accordance with modern practice we have made the following assumptions:

Traverse.—6 inches in all cases.

Bobbin head diameter.—Top ¼ inch less than ring diameter for rings larger than 2½ inches, and ½ inch less than ring diameter for rings 2½ and less. Bottom head ¼ inch less than diameter of ring in all cases.

Gauge of frame.—1 inch more than diameter of ring in all cases.

Roll speed is figured in exact proportion to the spindle speed and twist, on the assumed basis that contraction in length due to twist is offset by the extra turns of the spindle that are necessary to wind the yarn on the bobbin.

For example: To find the roll speed, divide the spindle speed by the circumference of the bottom roll and then divide the result by the twist per inch.

As bottom roll is 1½ inches in dia. the circumference $=3.1416\times1.5=4.7124$.

Spindle speed for No. 6 yarn is $4500\div4.7124=954.92$.

If twist with multiplier 4 is used consult the twist table which gives 6.93 for the square root of 6 multiplied by 4.

$954.92\div6.93=137.8$ as number of revolutions. The tables give 138 as the nearest equivalent.

Production is figured directly from the delivery of the front roll.

Taking the example of No. 6 yarn as above multiply the circumference—4.7124 inches by 138 turns per minute=650.3112 inches of delivery per minute. $650.3112\times600=390186.72$ inches of delivery per day. As there are 30,240 inches in a hank, $390186.72\div30{,}240=12.9$ hanks per day$\div3$ (The number of 6 two-ply)$=4.3$ pounds per day, the theoretical production of continuous running.

PER CENT. OF ALLOWANCE FOR STOPS IN TWISTING.

Number of Yarn.	2 Ply.	3 Ply.	4 Ply.	6 Ply.
6	14	15	17	20
7	14	15	16	18
8	13	14	15	17
9	13	14	15	16
10	12	13	14	15
12	12	13	14	15
14	11	12	13	14
16	11	12	13	14
18	10	11	12	13
20	10	11	12	13
22	9	10	11	12
24	9	10	11	12
26	9	9	10	11
28	8	9	10	11
30	8	9	9	10
32	8	8	9	10
34	7	8	9	9
36	7	8	8	9
38	7	7	8	9
40	6	7	8	8
42	6	7	7	8
44	6	6	7	8
46	5	6	7	7
48	5	6	6	7
50	5	5	6	7
60	5	5	6	6
70	4	5	5	6
80	4	5	5	6

In order to make a proper allowance for loss of time due to doffing, etc., it is necessary to find out what results are actually obtained and work out a systematic table. The above basis has been assumed for our own figures. The percentage varies with the ply and number of yarn, but not with the twist.

Taking the same problem as before, with the theoretical product of 4.3 pounds, the table would recommend a percentage reduction of 14 per cent. $4.3 \times .14 = .602$

$4.3 - .602 = 3.69$—Answer

Same as given in the Production tables.

TABLE SHOWING NUMBER OF POUNDS OF TWISTED YARN PRODUCED IN 10 HOURS—2 PLY.
FRONT ROLL 1½ IN. IN DIAMETER IN ALL CASES.

No. of Yarn to be Twisted.	Rev. of Spindle per Minute.	Dia. of Ring in Inches.	Dia. of Bobbin Barrel.	Weight of Yarn in Pounds on Bobbin.	Multiplier 3.		Multiplier 4.		Multiplier 5.		Multiplier 6.	
					Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.
6	4500	3	1¼	.42	184	4.92	138	3.69	110	2.94	92	2.47
7	4500				170	3.90	127	2.67	102	2.34	85	1.95
8	4500				159	3.22	119	2.41	95	1.93	79	1.60
9	4500				150	2.70	112	2.01	90	1.63	75	1.36
10	4500				142	2.33	107	1.76	85	1.40	71	1.17
12	5300	2½	1	.331	153	2.10	115	1.57	91	1.25	76	1.04
14	5300				141	1.67	106	1.25	85	1.01	70	.83
16	5300				132	1.37	99	1.02	79	.82	66	.68
18	5300				125	1.17	93	.87	75	.70	62	.58
20	5300				118	.99	89	.75	72	.61	59	.50
22	6000	2¼	1	.247	128	.99	96	.74	76	.59	64	.50
24	6000				122	.86	92	.65	73	.52	61	.43
26	6000				118	.77	88	.58	70	.46	58	.39
28	6000				113	.69	85	.52	68	.42	56	.34
30	6000				109	.62	82	.47	65	.37	54	.31
32	6000				106	.57	79	.42	63	.34	53	.28
34	6000				103	.52	76	.39	61	.31	51	.26
36	7000	2	⅞	.180	116	.56	87	.42	70	.34	58	.28
38	7000				114	.52	85	.39	68	.31	56	.26
40	7000				111	.49	83	.36	66	.29	55	.24
42	7000				108	.45	81	.34	64	.27	54	.23
44	7000				106	.42	79	.31	62	.25	52	.21
46	7000				104	.40	77	.30	61	.23	51	.19
48	7000				101	.37	75	.28	60	.22	50	.19
50	7500	1¾	⅞	.117	106	.38	79	.28	63	.22	53	.19
60	7500				97	.29	72	.21	58	.17	48	.14
70	8000				95	.24	71	.18	57	.15	47	.12
80	8000				89	.20	67	.15	53	.12	44	.10

TABLE SHOWING NUMBER OF POUNDS OF TWISTED YARN PRODUCED IN 10 HOURS—3 PLY.
FRONT ROLL 1½ IN. IN DIAMETER IN ALL CASES.

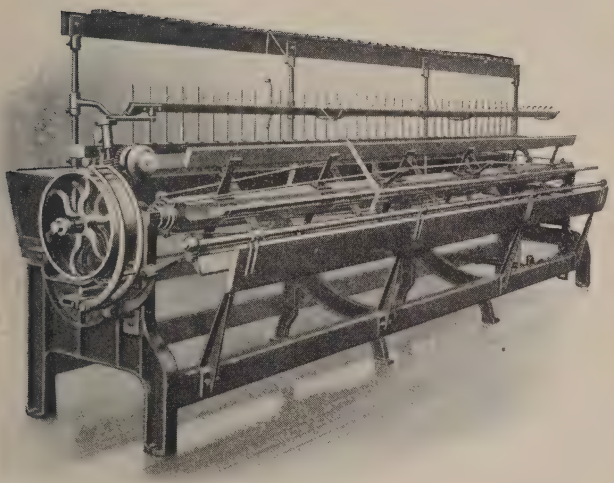
No. of Yarn to be Twisted.	Rev. of Spindle per Minute.	Dia. of Ring in Inches.	Dia. of Bobbin Barrel.	Weight of Yarn in Pounds on Bobbin.	Multiplier 3.		Multiplier 4.		Multiplier 5.		Multiplier 6.	
					Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.
6	3700	3½	1¼	.645	185	7.35	139	5.52	111	4.40	93	3.69
7	3700				172	5.87	129	4.40	103	3.51	86	2.93
8	3700				161	4.87	120	3.62	96	2.86	80	2.41
9	3700				151	4.05	113	3.03	90	2.41	76	2.04
10	3700				144	3.51	108	2.64	86	2.10	71	1.73
12	4500	3	1¼	.420	159	3.23	119	2.42	96	1.95	80	1.63
14	4500				148	2.61	110	1.94	89	1.57	74	1.31
16	4500				138	2.73	103	1.59	83	1.28	69	1.06
18	4500				130	1.80	97	1.34	78	1.08	65	.90
20	4500				124	1.55	92	1.15	74	.91	62	.77
22	5300	2½	1	.331	139	1.59	104	1.19	83	.95	69	.78
24	5300				133	1.39	100	1.05	80	.84	66	.69
26	5300				128	1.25	96	.94	76	.75	64	.63
28	5300				123	1.12	92	.84	74	.67	62	.56
30	5300				119	1.01	89	.76	71	.60	59	.50
32	5300				115	.92	86	.69	69	.55	57	.45
34	5300				112	.85	83	.63	67	.51	56	.42
36	6000	2¼	1	.247	123	.88	92	.66	74	.53	61	.44
38	6000				120	.82	89	.61	72	.49	60	.41
40	6000				117	.76	87	.57	70	.46	58	.37
42	6000				114	.71	85	.53	68	.42	57	.35
44	6000				111	.67	83	.50	67	.40	56	.33
46	7000	2	⅞	.180	127	.73	95	.54	76	.44	63	.36
48	7000				124	.68	93	.51	74	.41	62	.34
50	7000				122	.65	91	.49	73	.39	61	.32
60	7000				111	.49	83	.37	66	.29	55	.24
70	8000	1¾	⅞	.117	117	.45	88	.33	71	.27	59	.22
80	8000				110	.37	82	.27	66	.22	55	.18

TABLE SHOWING NUMBER OF POUNDS OF TWISTED YARN PRODUCED IN 10 HOURS—4 PLY.
FRONT ROLL 1½ IN. IN DIAMETER.

No. of Yarn to be Twisted.	Rev. of Spindle per Minute.	Dia. of Ring in Inches.	Dia. of Bobbin Barrel.	Weight of Yarn in Pounds on Bobbin.	Multiplier 3.		Multiplier 4.		Multiplier 5.		Multiplier 6.	
					Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.
6	3000	4	1½	.855	174	9.00	130	6.72	104	5.38	87	4.50
7	3000				161	7.22	121	5.43	97	4.35	80	3.59
8	3000				150	5.96	113	4.49	90	3.58	75	2.98
9	3000				142	5.02	106	3.74	85	3.00	71	2.51
10	3000				135	4.34	101	3.25	81	2.61	67	2.16
12	3700	3½	1¼	.645	152	4.07	113	3.03	91	2.44	76	2.04
14	3700				140	3.25	105	2.47	84	1.95	70	1.63
16	3700				131	2.66	98	1.99	79	1.61	65	1.32
18	3700				124	2.27	93	1.70	74	1.35	62	1.13
20	3700				117	1.93	88	1.45	70	1.15	58	.95
22	4500	3	1¼	.420	136	2.06	102	1.54	81	1.22	68	1.03
24	4500				130	1.80	97	1.34	78	1.08	65	.90
26	4500				125	1.60	94	1.21	75	.96	62	.79
28	4500				120	1.44	91	1.09	72	.87	60	.72
30	4500				116	1.32	88	.99	70	.79	58	.66
32	4500				112	1.19	85	.90	68	.72	56	.59
34	4500				109	1.09	82	.82	66	.66	55	.55
36	5300	2½	1	.331	125	1.20	94	.90	75	.72	63	.60
38	5300				122	1.10	91	.82	73	.66	61	.55
40	5300				119	1.02	89	.77	71	.61	59	.51
42	5300				116	.96	87	.71	69	.57	58	.48
44	5300				113	.89	85	.67	68	.54	57	.45
46	7000	2	⅞	.180	146	1.12	110	.83	88	.67	73	.55
48	7000				143	1.04	107	.78	86	.63	72	.53
50	7000				140	1.00	105	.74	83	.58	70	.49
60	7000				128	.76	96	.56	77	.45	64	.37
70	8000	1¾	⅞	.117	135	.69	101	.51	81	.41	68	.34
80	8000				126	.56	95	.42	76	.34	64	.28

TABLE SHOWING NUMBER OF POUNDS OF TWISTED YARN PRODUCED IN 10 HOURS—6 PLY.
FRONT ROLL 1½ IN. IN DIAMETER IN ALL CASES.

No. of Yarn to be Twisted.	Rev. of Spindle per Minute.	Dia. of Ring in Inches.	Dia. of Bobbin Barrel.	Weight of Yarn in Pounds on Bobbin.	Multiplier 3.		Multiplier 4.		Multiplier 5.		Multiplier 6.	
					Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.
6	2500	4½	1½	1.160	177	13.24	133	9.95	106	7.93	89	6.66
7	2500				164	10.84	123	8.13	98	6.48	82	5.42
8	2500				153	8.93	115	6.71	92	5.37	77	4.49
9	2500				145	7.59	109	5.71	87	4.56	72	3.77
10	2500				137	6.56	103	4.93	82	3.93	69	3.30
12	3000	4	1½	.855	150	5.96	113	4.49	90	3.58	75	2.98
14	3000				139	4.80	105	3.62	83	2.86	69	2.38
16	3000				130	3.93	98	2.96	78	2.36	65	1.97
18	3000				123	3.34	92	2.50	74	2.01	61	1.65
20	3000				116	2.83	87	2.12	70	1.71	58	1.42
22	3700	3½	1¼	.645	137	3.08	103	2.32	82	1.84	68	1.53
24	3700				131	2.70	98	2.02	79	1.63	65	1.34
26	3700				126	2.42	95	1.83	76	1.46	63	1.21
28	3700				121	2.16	91	1.63	73	1.30	61	1.09
30	3700				117	1.97	88	1.48	70	1.18	59	.99
32	3700				114	1.79	85	1.34	68	1.07	57	.90
34	3700				110	1.65	83	1.25	66	.99	55	.83
36	4500	3	1¼	.420	130	1.84	98	1.39	78	1.11	65	.92
38	4500				127	1.71	95	1.28	76	1.02	63	.87
40	4500				124	1.60	91	1.18	74	.96	62	.80
42	4500				121	1.49	90	1.11	72	.88	60	.73
44	4500				118	1.39	88	1.03	70	.82	59	.69
46	5300	2½	1	.331	136	1.54	102	1.15	81	.92	68	.77
48	5300				133	1.45	100	1.09	80	.87	66	.72
50	5300				130	1.36	98	1.02	78	.81	65	.68
60	5300				119	1.05	89	.78	71	.62	59	.52
70	6500	2	⅞	.180	135	1.02	101	.76	81	.61	67	.50
80	6500				126	.84	95	.62	76	.50	63	.42



OUR STANDARD REEL.

Our reel is practically the only one of our products which is not protected by patents, and therefore enters into open competition with other similar machinery. We have tried to secure approval of possible customers by making this machine a little better than any other, and we do not care to meet the prices of poorer reels. We believe our reel easier to operate than any other. The following special points are worthy of consideration: Our **traverse motion** is **geared** and **positive,** winding a well-bound skein.

The **bearing on the driven end** is set to **ball and socket joint,** so that it cannot be strained in lifting swift for removal of yarn. The bearing on the opposite end is protected and **prevents any oiling of skeins.**

The **releasing arms** and **traverse** are furnished with **metal bearings,** fitted with **metal boxes.**

The shaft is of wood, for lightness, and superior to any other material for this purpose.

The bobbin box has waste boxes at each end, and is **protected from any drip** from the spindles.

We fit these reels with front spindles for cops, or spinning or twisting bobbins, each spindle being removable independent of others. The **spindle bearings** have a **hinged protecting board,** preventing dirt and flyings from lodging.

A gong is attached to strike at the completion of each hank of 840 yards, or when any other length desired has been reeled. We recommend the maximum length of reel not to exceed 65 spindles.

We claim a **larger production** of a **better product,** within a given time, with **less waste.**

SPECIFICATION FOR REELS.

Number of reels with driving pulleys on right hand end.....
Number of reels with driving pulleys on the left hand end.....
Number of spindles in each reel.....
Space between spindles.....
Size of skein desired (54, 60 or 72 inch.).....
Reel to be belted from (above or below).....
Going to strike at each (hank or——yards).....
Yarn to be reeled from (spool, bobbin, or cop.) Send sample full of yarn.....
Reels to be shipped (on shoes, in crates, or taken down and boxed).....
Ship via.....

Reel Production Tables.

It is practically impossible to give any definite figures of reel production that can apply to the widely varying conditions. We therefore simply give a table of the theoretical maximum product if running were continuous, to furnish a basis from which a proper percentage reduction may be made. Reels are stopped anywhere from fifty to eighty per cent. of their possible running time in actual practice.

This table is for **single yarn,** and gives ten hours continuous product in pounds per spindle for the varying sizes. For yarns numbering from 1 to 9 inclusive, take the products for 10-90, etc., and multiply by 10. For instance, the product of a 54-inch reel at 120 revolutions on No. 5 yarns would be that of No. 50 yarn (2.57) multiplied by 10=25.7 pounds.

Reel Production Tables—Theoretical Continuous Result in Pounds per Spindle per Day.

No. Yarn.	54 Inch Reel.				60 Inch Reel.				72 Inch Reel.				90 Inch Reel			
	Revolutions per Minute.															
	120	130	140	150	120	130	140	150	110	120	130	140	100	110	120	130
10	12.85	13.92	15.00	16.07	14.28	15.47	16.66	17.85	15.71	17.14	18.57	20.00	17.85	19.64	21.42	23.21
11	11.68	12.65	13.63	14.60	12.98	14.06	15.14	16.22	14.28	15.58	16.88	18.18	16.22	17.85	19.47	21.10
12	10.70	11.60	12.50	13.39	11.90	12.89	13.88	14.87	13.09	14.28	15.47	16.66	14.87	16.36	17.85	19.34
13	9.89	10.70	11.53	12.36	10.98	11.90	12.81	13.73	12.08	13.18	14.28	15.38	13.73	15.10	16.47	17.85
14	9.17	9.94	10.71	11.47	10.20	11.05	11.90	12.75	11.22	12.24	13.26	14.28	12.75	14.02	15.30	16.57
15	8.57	9.28	10.00	10.71	9.50	10.31	11.10	11.90	10.47	11.42	12.38	13.33	11.90	13.09	14.28	15.47
16	8.03	8.70	9.38	10.04	8.92	9.66	10.41	11.15	9.81	10.71	11.60	12.50	11.15	12.27	13.38	14.50
17	7.56	8.19	8.83	9.45	8.40	9.10	9.80	10.50	9.24	10.08	10.92	11.76	10.50	11.55	12.60	13.65
18	7.14	7.74	8.34	8.93	7.93	8.59	9.25	9.91	8.72	9.52	10.31	11.11	9.91	10.91	11.90	12.89
19	6.76	7.33	7.90	8.46	7.52	8.14	8.77	9.40	8.27	9.02	9.77	10.52	9.40	10.33	11.27	12.21
20	6.42	6.96	7.50	8.04	7.14	7.74	8.33	8.93	7.86	8.57	9.28	10.00	8.93	9.82	10.71	11.60
21	6.12	6.63	7.15	7.65	6.80	7.37	7.94	8.50	7.49	8.16	8.84	9.52	8.50	9.35	10.20	11.05
22	5.84	6.33	6.82	7.30	6.49	7.03	7.57	8.12	7.15	7.80	8.44	9.10	8.12	8.93	9.74	10.55
23	5.59	6.05	6.53	6.99	6.21	6.73	7.25	7.77	6.83	7.45	8.07	8.70	7.77	8.55	9.32	10.09
24	5.35	5.80	6.25	6.70	5.95	6.45	6.94	7.43	6.55	7.15	7.74	8.33	7.43	8.19	8.92	9.67
25	5.14	5.57	6.00	6.43	5.71	6.19	6.67	7.14	6.28	6.86	7.43	8.00	7.14	7.86	8.57	9.29
26	4.94	5.36	5.77	6.18	5.49	5.95	6.40	6.87	6.04	6.60	7.15	7.70	6.87	7.55	8.24	8.93
27	4.76	5.16	5.55	5.95	5.29	5.73	6.17	6.61	5.82	6.35	6.88	7.41	6.61	7.27	7.93	8.60
28	4.59	4.97	5.36	5.74	5.10	5.53	5.95	6.38	5.61	6.13	6.63	7.15	6.38	7.02	7.65	8.29
29	4.43	4.80	5.17	5.54	4.92	5.33	5.75	6.15	5.42	5.91	6.41	6.90	6.15	6.78	7.39	8.00
30	4.28	4.64	5.00	5.35	4.76	5.15	5.55	5.95	5.24	5.72	6.19	6.67	5.95	6.55	7.13	7.74
40	3.21	3.48	3.74	4.01	3.57	3.87	4.16	4.47	3.93	4.29	4.64	5.00	4.47	4.91	5.35	5.80
50	2.57	2.78	3.00	3.21	2.86	3.10	3.33	3.57	3.14	3.43	3.71	4.00	3.57	3.93	4.28	4.64
60	2.14	2.32	2.50	2.68	2.39	2.58	2.78	2.98	2.62	2.86	3.10	3.34	2.98	3.28	3.57	3.87
70	1.83	1.99	2.14	2.29	2.04	2.21	2.38	2.55	2.24	2.45	2.65	2.86	2.55	2.81	3.06	3.32
80	1.60	1.74	1.87	2.01	1.78	1.93	2.08	2.23	1.96	2.14	2.32	2.50	2.23	2.46	2.68	2.90
90	1.42	1.55	1.67	1.78	1.59	1.72	1.85	1.98	1.74	1.90	2.06	2.22	1.98	2.18	2.38	2.58
100	1.28	1.39	1.50	1.60	1.42	1.54	1.66	1.78	1.57	1.71	1.85	2.00	1.78	1.96	2.14	2.32

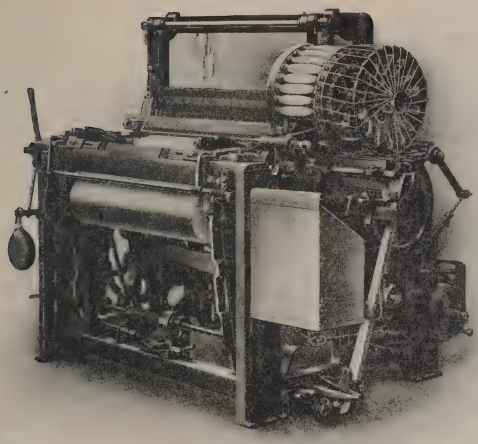
DIMENSIONS OF YARN REELS.

Size of ring	1⅜	1½	1⅝	1¾	1⅞	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼	4½
Outside diameter of bobbin or cop	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼
Space between centres of spindles	2	2⅛	2¼	2⅜	2½	2⅝	2¾	3	3¼	3½	3¾	4	4¼	4½	4¾	5

Number of spindles.	LENGTH OF REELS OVER ALL, IN FEET AND INCHES.															
25	.....	.....	.....	.....	.....	.....	.....	8 5	8 11	9 5	9 11	10 5	10 11	11 5	11 11	12 5
30	.....	.....	.....	8 1⅞	8 5½	8 9⅛	9 0¾	9 8	10 3¼	10 10½	11 5¾	12 1	12 8½	13 3½	13 10½	14 6
35	.....	8 5¼	8 9½	9 1¾	9 6	9 10¼	10 2½	10 11	11 7½	12 4	13 0½	13 9	14 5½	15 2		
40	8 11	9 3⅞	9 8¾	10 1⅝	10 6½	10 11⅜	11 4¼	12 2	12 11¾	13 9½	14 7¼	15 5				
45	9 9	10 2½	10 8	11 1½	11 7	12 0½	12 6	13 5	14 4	15 3						
50	10 7	11 1⅛	11 7¼	12 1⅜	12 7½	13 1⅝	13 7¾	14 8	15 8¼							
55	11 5	11 11¾	12 6½	13 1¼	13 8	14 2¾	14 9½									
60	12 3	12 10⅜	13 5¾	14 1⅛	14 8½	15 3⅞										
65	13 1	13 9¾	14 5	15 1												
70	13 11	14 7⅝														
75	14 9															

WIDTH OF REELS, IN FEET AND INCHES.			
Size of skein	54″	60″	72″
Extreme width of reel	3 0	3 2	3 6

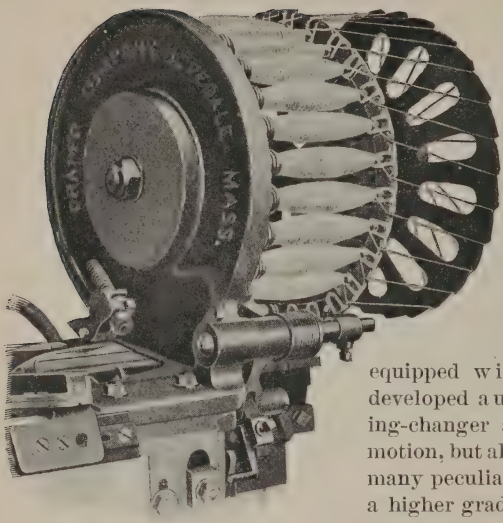
We recommend maximum length of reel not to exceed 15 ft. 6 in. Diameter of driving pulleys, 12 in., with 1¾ in. face.



FRONT VIEW OF I MODEL.

THE NORTHROP LOOM.

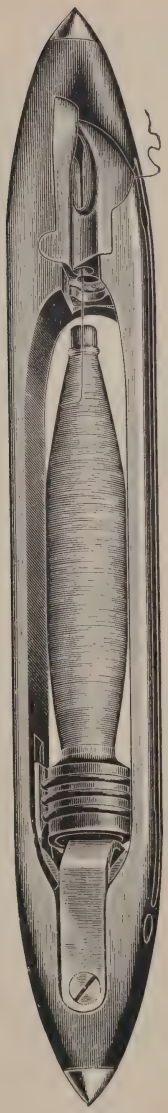
While looms are now our most important product, we do not intend to give full detail about them in this catalogue, for they require a separate volume of their own. Those wishing to know more about this wonderful machine can send for our book, "Labor Saving Looms," now in its second edition. The success of automatic weaving is thoroughly established, as we have sold over 125,000 complete Northrop Looms to date, without counting those built abroad by our various licensees. Our success has stimulated competition, there being several attempts to introduce the old shuttle-changing principle, so often tried and so often discredited. It has been found difficult to make any of these devices salable without infringement of our own patents, and we have several law suits now in progress with the more prominent of the builders. It is naturally easy to get some orders for inferior machines from that class of purchaser who will take a cheaper machine without full investigation of the relative merits of those offered for sale. We are perfectly willing to let the trial of the looms themselves determine their relative value as competing machines, and we only interest ourselves to publicly correct the public statements of our competitors when they attempt to comment adversely on our own product in emphasizing their supposed and unproved superiority.



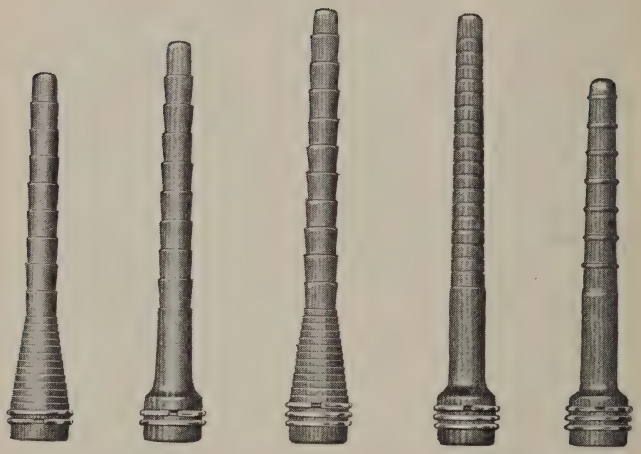
25–Bobbin Hopper.

Our own loom and its parts are generally understood by the trade at present. We are building a loom after an experience of some twelve years, which not only is equipped with a highly developed automatic filling-changer and warp-stop-motion, but also incorporates many peculiar novelties and a higher grade of workmanship than is common to any other loom ever manufactured. Considering the hopper, or battery, as the most important element, we still use the large 25-bobbin design with various minor improvements. The retaining devices for the small end of the bobbin are supplied with coiled springs which operate more easily than formerly, allowing quicker introduction of bobbins into place. The same hopper will do for either bobbins or cops.

Our warp-stop motions are furnished in various styles. Our steel heddle motion continues its popularity on 2-harness work, and we have devised several methods of adapting it for more harnesses. We have several forms of stop-motion for use with ordinary forms of harness, each having its peculiar field. They are all of the drop-wire type, but they use different styles of drop-wire and different methods of application. Our older form uses one drop-wire for two or more threads, and is situated directly back of the usual cotton harness. Another form uses two or more rows of drop wires, situated so as to take the place of the usual lease rods, as the drop wires do the leasing themselves. Another form retains lease rods, but uses a small, light drop, especially adapted to fine warp or close sley. The steel heddle form is less expensive for drawing in, but it is more limited in its range of application. Conditions vary so much that we prefer to deal with each particular case as it comes to us.



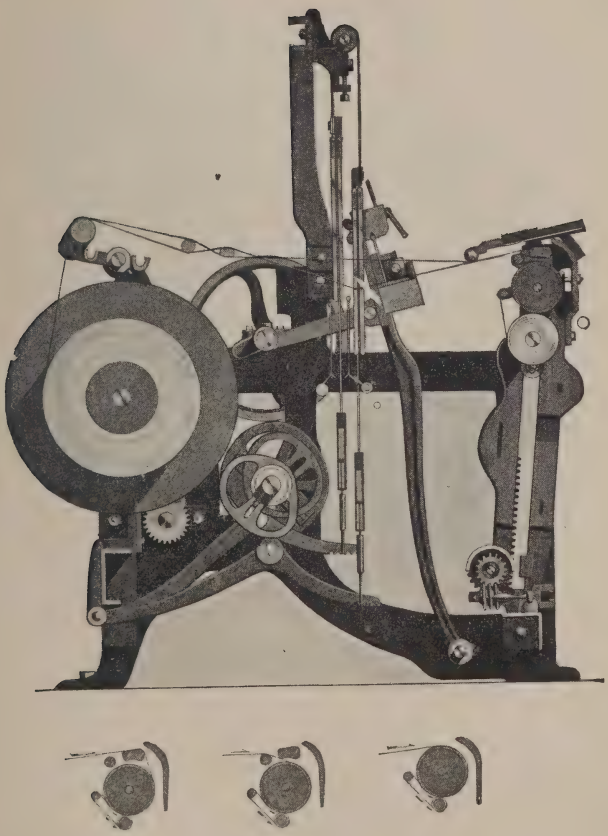
Our shuttles are now fairly standardized, and the illustrations show the popular patterns now advised. We duplicate any of our older patterns on request.



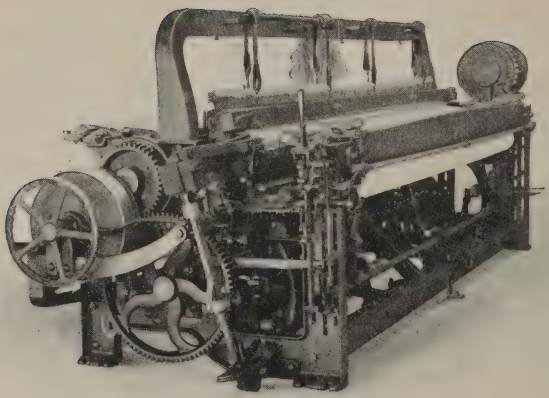
We now manufacture our own bobbins for Northrop looms. These bobbins are patented and have always been sold directly by us to our customers, although formerly manufactured for us elsewhere. We believe it better to control the manufacture of this product to ensure the prompt filling of orders, and to have more personal knowledge of the difficulties that arise in meeting the necessary conditions. We know these bobbins from the tree to the packing box, and we manufacture them on special machinery of our own construction, which ensures a greater accuracy than ever before possible. We intend to make the very best filling bobbins ever manufactured, even if there is less profit to ourselves in taking extra care.

For match-pick weaving we have developed our feeler construction to give more perfect results with less waste on the bobbins than formerly. We are also giving attention to improving the design to prevent wear and allow closer adjustment. Our bunch-building mechanisims for use in spinning filling for feeler looms are also much improved. While we continue the use of our high roll take-up on the great majority of our looms, we also build looms with the old fashioned breast-beam and low take-up roll for special weaves, when required by our customers.

Our Draper-Roper let-off is now a standard, giving almost universal satisfaction. With certain goods we also apply a friction to give extra drag on the beam.

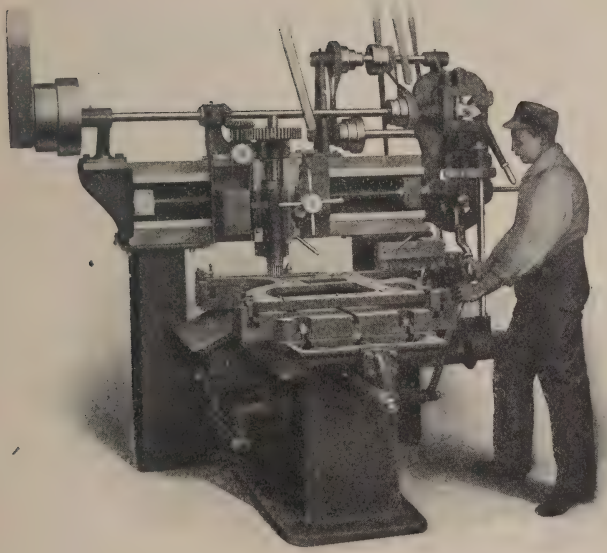


As will be noted in the cross-section of a Northrop loom, as shown in the cut, we have recently made a material modification in our Cut Motion, in order to cover various requirements of weaving, it being found necessary in certain instances to have a greater length of cloth from the reed to the take-up roll than our former high-roll arrangement allowed. The three drawings under the main illustration show other methods of guiding the cloth within the range of the mechanism. We still make the regular high-roll take-up for those who wish to duplicate looms or do not need the extrá winding.



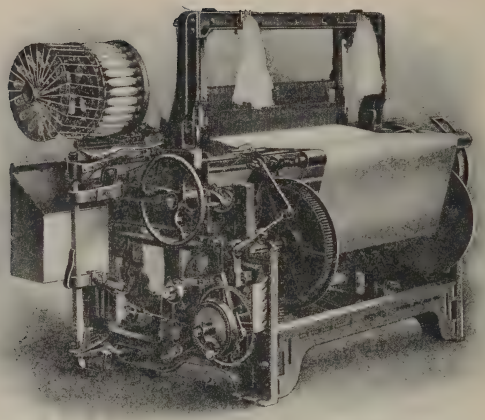
We have had gratifying success with our recent "L" Model loom, or wide pattern, for cloth from 72 to 108 inches in width. We drive this loom from an auxiliary shaft, with pulley geared to run at higher speed than the crank shaft. We use a clutch pulley and band brake, recently improved and properly effective.

We no longer limit ourselves to any particular line of weaving within the single shuttle class, for we have spread the application of the Northrop system to include nearly every style of fabric manufactured. Our looms are run with jacquard motions, dobby motions, side-cam motions, bag motions, on towels and handkerchiefs, flat duck, corduroy, denims, window-shade goods, all classes of sheetings and prints, muslins, sateens, napped fabrics, drills, twills, stripes, etc. We have looms running with filling as fine as 140s and warp as fine as 100s. We have had several mills completely equipped with cop looms, although there has been a curious idea prevailing to the effect that the Northrop loom was not adapted for cop filling. On many grades of product, Northrop loom goods are preferred by the buyer; in fact, we have sold looms to mills because their customers insisted on Northrop loom products. We are just starting to introduce the Northrop principles for lines outside the cotton industry, having shown great advantages in the weaving of certain woolen and worsted goods.



All of our loom frames are now milled, the cross pieces, or girts, being also milled to exact length so that the looms are uniform and the frames set up in correct alignment. No other American builder goes to this expense; in fact, they cannot afford such expense at the prices at which common looms are sold.

The Northrop loom is of peculiar advantage at the present time because of the lessening of the labor demanded. The cotton mills of the country are suffering from scarcity of help; in fact, this scarcity has prevented the building of the proper proportion of new mills. The increase of spindles for the last few years is of small moment compared with the increase in England, where 7,000,000 new spindles are understood to have been started. The Northrop loom needs less than half the weavers for the same product. It would save more than half the cost of weaving did the owners take all the profits. It has proved its advantages so many times and in so many places that repetition on this point is becoming tedious.



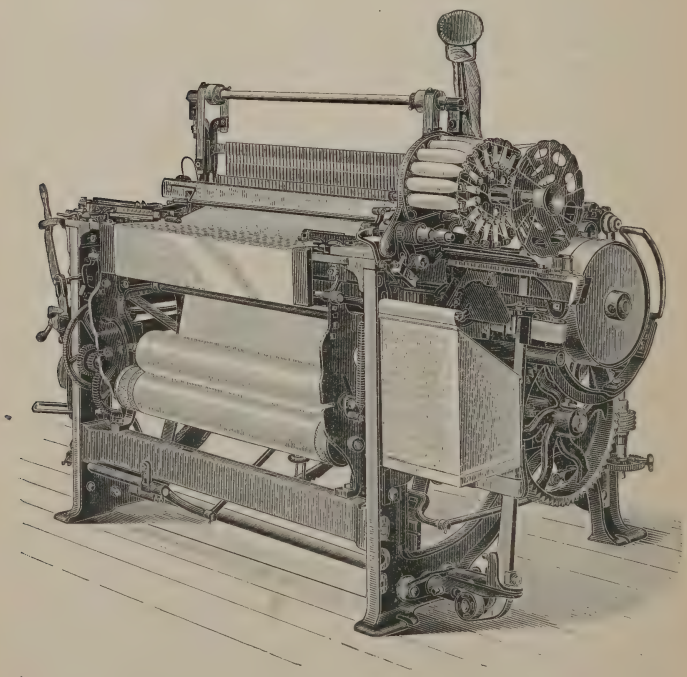
Rear View I Model

Our price for Northrop looms of different models has been practically stationary for years, in spite of the fact that we have been continually improving the loom as a machine, with an increase of cost for nearly every change. We have not only added more weight, but we have added the extra machine processes noted. We have increased the size and capacity of our hopper, we have greatly increased the cost of our cut motion and we supply two forks instead of one to practically all of our looms. Our new let-off is a much more expensive mechanism, and there are many other details of similar character. Sometime ago we figured that the cost thus added, as compared with our earlier constructions, was equivalent to fully $15 per loom. Since that time, the price of materials has increased beyond all expectation, so that we are paying more for our iron, steel and lumber. It would certainly be conservative to say that we are giving our customers looms at a price $20 less than they should be charged in proportion to our early established price for the machine and conditions then covered. It must also be remembered that we supply assistance and supervision in the starting and running of our looms, which amounts to many dollars per loom each. We explain these matters with no intention of appealing for sympathy, as we still make a profit,—and we ought to make a profit. We make less profit, however, than many other introducers of patented machinery; in fact, in view of the benefits conferred, we think our net return from each sale singularly moderate.

There seems to be a sort of vague understanding throughout the trade that several other machinery builders will introduct filling-changing looms to the trade within a short period of time, in view of the expiration of several of our important patents. Customers are being urged to hold off orders until such time, to profit by the supposedly lower prices at which they can obtain satisfactory automatic looms. It is perfectly true that some of the patents showing important principles of operation will expire at a comparatively early period, but **these patents only allow the use of mechanism which we ourselves did not find satisfactory for continued mill use until they were supplemented by improvement and further inventions.** The earliest commercial looms furnished by us for the trade, were delivered in 1895. Important patents covering several of their essentials, will not expire for many years to come. It is difficult for anyone to comprehend the wide scope of our patent protection; in fact, we have had instances where competition in our patented machinery was started by those who had not seen all our patents and who were promptly ready to desist as soon as the patents were shown them. We own many patents that do not stand in our name on the records having been acquired since their issue.

Those who have not had our experience with this mechanism may think it easy to devise substitute devices, but we reached comparative perfection in this Northrop loom line only after seven years of experiment in the discarding of such substitutes. It is plainly evident to any sensible man that, at the lowest limit, the Patent Office protection of 17 years only allows the copyist a chance to duplicate a mechanism 17 years old. As a matter of fact, in view of the time taken in applying for patents, etc., this period is often much longer. Our competitors to-day can, with the lowest limit, only duplicate the devices with which we were experimenting in 1890. Even were they able to duplicate the looms which we sent out to the trade in 1895, by 1912 (now 5 years distant) they would still be limited to our early, crude loom, which will have had 17 years of added improvement in the interim. We know our loom of to-day is vastly superior to that of 1895. We believe our loom of 1912 will be superior to that we are now making. The improvements are well worth the difference between the price we ask and the possible price that our competitor could charge. Remember, that those who wait are losing possible profits in the meantime. There is little economy in waiting 5 years to buy an obsolete machine, at a small saving in cost, when the loss per loom for each of the 5 years might be $20 to $30 or even more.

We find that several users of Northrop looms are buying wooden shuttle blanks cut to receive Northrop shuttle parts, from outside sources, taking parts from Northrop shuttles in which the wood is worn out to put in them. We call attention to the fact that we ourselves sell shuttle blanks cut to receive our parts, and charge a low price for the same. We cannot see how anyone can afford to sell them for less than our charges and furnish a good article. There is not sufficient profit to ourselves in this price to make us very eager for the trade, but we do like to have our looms give good results, and we frankly do not believe that shuttle blanks made by other parties will hold our shuttle parts so uniformly in proper position as our own. We disclaim any responsibility for the operation of our machinery when used with devices or repairs that we have not furnished. If the bobbins in a Northrop shuttle are not centrally held they will break more filling. This might not be detected unless a careful comparison were made.



OLD STYLE (B MODEL) NORTHROP LOOM.

SPEED RECOMMENDED FOR DRAPER LOOMS FOR MEDIUM WEIGHT GOODS.

28″	190 to 195	60″	128 to 132
30″	185 to 190	64″	124 to 128
32″	180 to 185	68″	120 to 124
34″	175 to 180	72″	116 to 120
36″	170 to 175	76″	112 to 116
38″	165 to 170	80″	108 to 112
40″	160 to 165	84″	104 to 108
42″	154 to 158	88″	100 to 104
44″	148 to 152	92″	96 to 100
46″	144 to 148	96″	94 to 96
48″	140 to 144	100″	90 to 94
52″	136 to 140	104″	88 to 90
56″	132 to 136	108″	86 to 88

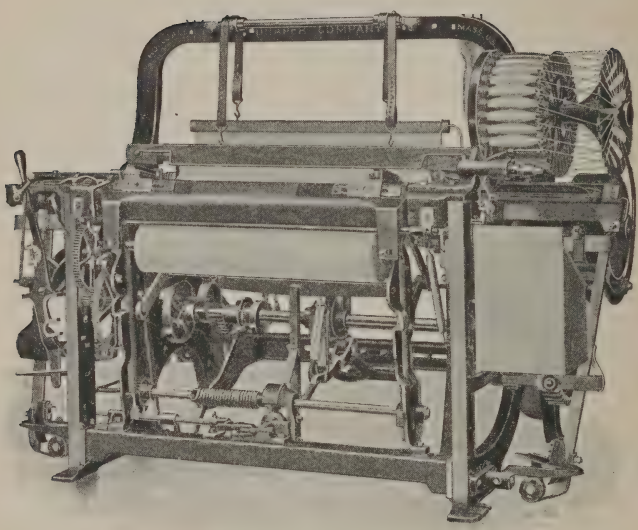
There is no reason why our loom cannot run at any speed attained by common looms of the same capacity. We never advocate extremes in this direction. In fact, on heavy goods we would consider the above table too high.

WE DESIGNATE OUR DIFFERENT LOOM MODELS AS FOLLOWS:

A MODEL.—Like those sold in 1895 to the Queen City Mill, and other early customers.
B MODEL.—Standard up to 1898.
C MODEL.—Never put out.

Above models now obsolete.

D MODEL.—First heavy pattern.
E MODEL.—Standard replacing the B Model.
F MODEL.—Extra heavy pattern for 72 inch goods and wider, replaced by L Model.
G MODEL.—A special pattern not to be duplicated.
H MODEL.—Heavy pattern. Side-cam corduroy loom.
I MODEL.—New construction for same goods as the E model.
J MODEL.—Special light two-harness loom.
K MODEL.—E Model widened to take 24 harness dobby.
L MODEL.—New extra heavy wide Model.



E Model Cotton Harness Loom.

SPECIFICATIONS OF NORTHROP LOOMS

Ordered from Draper Company, Hopedale, Mass.

Make out separate specifications for each style and size of loom.

For..... Date ordered..... 190....

Address .....

Number..... Size ..... Model.....

.....Right-Hand Belt from above.

.....Left-Hand Belt from above.

.....Right-Hand Belt from below.

.....Left-Hand Belt from below.

Kind of cloth to be woven..... Width..... Sley.....

Number of Picks per inch.....

Number of threads in Warp.....

NOTE:—We furnish one pick gear with each loom.

Number of Warp Yarn.....

Number of Filling Yarn.....

Shall looms duplicate others in the mill?.....

If so, give date of previous order .....

Is filling on Bobbins or Cops?.....

Total length of Bobbin or Cops?.....

NOTE:—It is necessary to send several sample cops with mule spindle, or bobbin and spindle. Our regular sizes of bobbins take 5 1-2″ traverse on a bobbin 6 3-4″ long; 6 1-8″ on a bobbin 7 3-8″ long; 6 3-4″ traverse on a bobbin 8″ long and 7 1-2″ traverse on a bobbin 8 3-4″ long. Our regular cop sizes are 5 1-2, 6 1-8 and 6 3-4 Traverse. Bobbins are patented, and must be ordered through us. At least 200 per loom should be provided. When cops are used we send 30 skewers with each loom for large battery; 20 skewers with each loom for small battery. These are charged extra.

Shall we make Bobbin or Cop Heads Standard Butt? .....

Give largest diameter of full filling Bobbin or Cop measured on the Yarn.....

Large or Small Battery?.....

Diameter of Spinning Ring.....

NOTE:—Large Battery takes 25 bobbins or cops. Small battery takes 15 bobbins or cops.

What style of Take-up?.....

NOTE:—Our "High Roll" construction admits of winding any diameter Cloth Roll up to 17″. Embodied with this we have three separate styles of Take-up.

Our regular pattern takes up with every pick and lets back to prevent thin places.

Our Worm Take-up without the let-back feature, is a positive take-up, and is especially designed for corduroys, velvets and similar fabrics, which require 200 picks per inch and above.

Our Worm Take-up with let-back is designed for those who require a positive take-up and still desire the let-back feature.

What style of Let-off?.....

NOTE:—We furnish Roper, Bartlett, Friction, Roper and Friction, or Bartlett and Friction combined.

On "L" Model looms we furnish Compound Let-off and Compound with friction; on Corduroy looms we furnish a special let-off.

If friction Let-off shall we order Chain, Fibre, or Rope Friction?.....

What Whip Roll Combination?.....

NOTE:—Drag Rolls are used only for very heavy weaves; heavy denims and goods of this character.

We recommend for most cloths Plain Pipe Whip Rolls; for heavy weaves, not taking Drag Rolls, Vibrating Whip Rolls, for very light weaves, Durkin Thick and Thin Place Preventers. Unless Vibrating Whip Rolls, Thick

and Thin Place Preventers or Drag Rolls are specified, we shall furnish with Plain Pipe Roll.

Will you have Feeler?.....

Will you have Single or Double Fork?.....

NOTE:—Double Fork Looms measure 2″ more between loom sides than single fork.

Is filling for these looms to be made on new or old frames?.....

If new frames, call for Bunch Builders on specification for spinning frames and specify how many you want equipped.....

If old frames, give maker of frames and how many Bunch Builders are wanted.....

NOTE:—When feeler is used an attachment on spinning frames, called the Bunch Builder, is required to wind bunch of yarn on bobbin.

What style Warp Stop-Motion is required?.....

NOTE:—We have three styles:

Steel harness using one steel heddle for every warp thread, adapted for 2-3-4 and 5 harness work.

Drop-wire Stop-motion for cotton harness, which requires one drop wire for every two warp threads in a two-harness loom adapted for 2-3-4 and 5 harness work.

Single Thread Lease-rod Stop-motion for cotton harness, using one drop wire for every warp thread. This stop-motion is adapted for any number of harnesses from 2 up.

Drop-wires and Heddles are extras and should be ordered in sufficient quantities for extra drawing-in sets. It is well to order about 20 per cent. more drop-wires or heddles than the looms figure for this purpose.

How many Steel Heddles or Drop-Wires?.....

How many looms arranged for 2 Harnesses?.....

How many looms arranged for 3 Harnesses?.....

How many up?.....How many down?.....

How many looms arranged for 4 Harnesses?.....

How many up?.....How many down?.....

How many looms arranged for 5 Harnesses?.....

How many up?.....How many down?.....

What style Harness Motion?.....

NOTE:—We furnish the Roll and Shaft Top Harness-motion or the Lacey Top.

We adapt our looms to take either the Stafford or Crompton Dobby.

We also furnish Special Side Cam Motion for Corduroys.

Are Cams on Cam Shaft or Auxiliary Shaft?.....

If Auxiliary Shaft, shall we send gears to run 2-3-4-5 shade?.....

Single or Double Jack Hooks?....(Not used with Steel Harness)
On what No. of Harnesses shall we set up looms?.....
How many up?.....How many down?.....
Shall we supply Dobby?.....
How many Harnesses?.....What style?.....
Shall we supply Single or Double Spring Jack or Direct Springs?.....
Is Independent Selvage Motion required?.....Plain or Tape?.....
What Diameter and Face of Driving Pulley?.....
What width of Belt?.....
Tight and Loose or Friction Pulley?.....

NOTE:—Regular size 12″ diameter, 2 1-4″ face, for 28″ loom. 14″ diameter, 2 1-4″ face, for 40″ loom. We strongly recommend this width of face, as wider pulleys are much more troublesome in shifting belts.

For 2 1-2″ belts and wider, we recommend friction pulleys.

We furnish 16 5-8″, 18″ and 20″ Beam Heads. Which do you require?.....

NOTE:—When 20″ heads are used looms measure 3″ more in depth. Heads for our broad sheeting looms are in all cases 16.″

Distance between Heads.....

NOTE:—For proper width between Beam Heads, we recommend 4″ more than size of loom. For those desiring extra space we supply Beams 5 1-2″ wider than the size of the loom.

We furnish 5″ and 6″ diameter Yarn Beams. Which do you require?.....

NOTE:—We recommend 6″ barrel for 20″ Beam Heads, also with smaller heads if fine yarn.

How many extra shuttles?.....

(Only one per loom included without extra cost.)

What style Temple will you have, 1 3-4 or 2 1-2 Roll?.....
How many Bobbins shall we order for you?.....
Style?.....Oil soaked?.....

NOTE:—Send sample spindle to fit Bobbins to.

For what number of picks shall we set up looms?.....
Will you have Bolton Loom Seats?.....

(One to each eight looms—no charge.)

NOTE:—Send us one complete reed such as you intend using on these looms. On orders for 25 to 100 looms, 2 reeds, over this amount 3. As the contraction on our High Roll Take-Up is considerably less on several classes of weaves than on other looms, it would be well to write us before ordering new reeds. The maximum reed space is 5″ wider than the size of the loom.

Pickers must be of short pattern not projecting above shuttle box.

We furnish sample sets of strapping and pickers without extra charge.

On Side Cam looms send us copy of Chain Draft.

By what lines shall we ship?.....

Remarks. .....

.....

SPECIAL POINTS FOR CONSIDERATION IN RUNNING NORTHROP LOOMS.

Since the forks operate the hopper, be careful that the forks pass freely through the grates at all times. There is an adjustment on the hopper latch finger, governing the motion of the transferrer, and there are eccentric pins on the lay swords to allow adjustment of the lay to bring it properly under the hopper. **Take pains in using these lay sword adjustments to move both of the pins equally;** otherwise, the lay will get an eccentric motion. The transferrer should place the bobbin in the shuttle without its contacting on the front or back of the shuttle itself, and the transferrer should not follow the bobbin into the shuttle so as to press perceptibly on it after the bobbin is fully into the spring. If the shuttle enters the box so far that the bobbin will strike too high up on the shuttle cover, an additional piece of leather must be put back of the picker-stick to compensate for the wear of the picker which allows the shuttle to get out of place.

The bobbins will not be brought properly under the transferrer, unless the hopper disc rotates easily. The hopper disc bearing should be kept oiled, care being taken not to drip oil on the bobbins. Weavers should fill the hoppers properly, not allowing spaces between bobbins. Weavers are often careless in threading the bobbins in the hoppers, apparently thinking it makes no difference as to how the threads run. To secure best results and least misthreading, the threads should run diagonally from the tips of the bobbins to the notches on the thread disc. The small notches at the side of the bobbin tip supports, are intended for the threads on cops only. They are of no advantage for bobbins.

Shuttle springs should be kept tight by taking up wear with the screw. The wood of the shuttle must be kept smooth or it will cut both warp and filling. The tips must also be kept smooth by emery cloth, if there is any tendency to roughness. Extra friction may be obtained by bunches of slasher waste or bristles, or lining the inside of the shuttle with flannel. The loom fixers must attend to this, as we cannot know in advance just what conditions the shuttles are to meet. Misthreading is due to improper position of the threads on the hopper, jamming of the shuttle eye, or getting the same choked by lint, weak filling, and too hard a pick.

Breakage of filling causes extra labor, as the weaver must put the bobbin back into the hopper. Every bobbin ought to weave off clean, and when there is extra breakage it is possibly due to a harsh pick, which causes the filling to throw out of the shuttle and catch on adjacent parts. Care should be taken to allow no cracks, projections, or corners, for such threads to loop around when throwing out of the shuttle.

Thin places are caused by the fork improperly striking the grid, by the forks rebounding improperly, or by the fork being raised by a dragging filling thread. Our present looms are equipped frequently with a double fork, which gives a double chance against faulty operation, and also with a projection on the lay known as a "trailing thread clearer." Our present lays are also equipped with a guiding device to prevent their getting out of position with relation to the forks.

Poor bobbins cause considerable trouble, especially those which have loose rings and rough tips. Bobbins are liable to swell, if the filling is dampened, requiring reaming, and after the reaming they may not fit the spindles properly. Our centrifugal clutch spindles allow a loose fit at the start, so there is less necessity for reaming.

Bunches in cloth are usually due to bobbins which do not start up on doffing, requiring the preliminary wind by the doffer to start the end on the bobbin. This preliminary wind is loosely wound and weaves off in a snarl from the shuttle. Some mills on fine goods have found it advisable to have all of the bobbins on a spinning frame which do not start in doffing, replaced by bobbins having enough yarn spun on them so that they may be properly pieced up. We believe this evil could be remedied in great part if doffers were made to take more care and not rushed so hard with the idea of hurrying the operation.

Warp stop-motions should be carefully tested to see that they operate properly and surely, without extra pressure on the heddles or drop wires. Bent and broken heddles and drop wires should be carefully weeded out at intervals.

Warp breakage is increased by attempts to get face on the

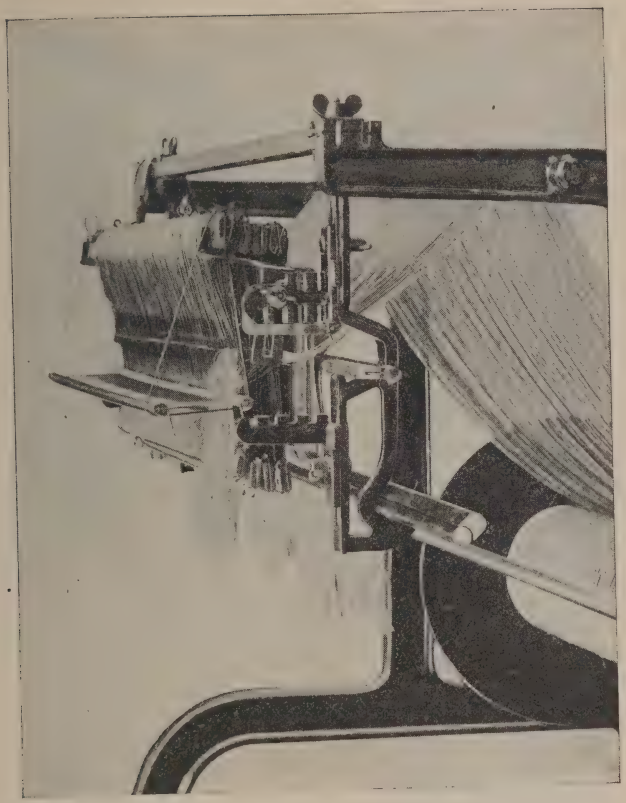
goods by straining one of the sheds, and is also affected by bad reeds, quick shedding, worn harness and bad knots. Feeler looms require careful adjustment; in fact the feeler itself requires more intelligent adjustment than any other part of the loom. **Care should be taken with feeler looms to see that the feelers are set to allow for sufficient rebound of the shuttle.** The action of the feeler can be easily tested by slipping bobbins that are nearly exhausted into the shuttle to see how the feeler operates. All of our present feelers are designed to allow for lost motion in the lay.

Cover on cloth may be obtained in several ways. Early crossing of the shade will assist; that is, crossing when the lay is about half way back. This will also help in avoiding reedy cloth. The face of the cloth can also be improved by raising the whip-roll and take-up roll, to keep the bottom shade tight. With certain kinds of goods, such as light lawns, the harness may have to be set so as to cross when the lay is at its extreme forward position, to avoid cracks in the cloth when the weaver starts up the loom.

Greater detail concerning these matters will be found in our large loom publication.

We have been very favorably impressed with recent installation of air-cleaning devices which blow the lint from the various parts of the loom onto the floor. Air-suction devices have been suggested, but we know of no successful trial of such a system at the present time for cotton mill purposes.

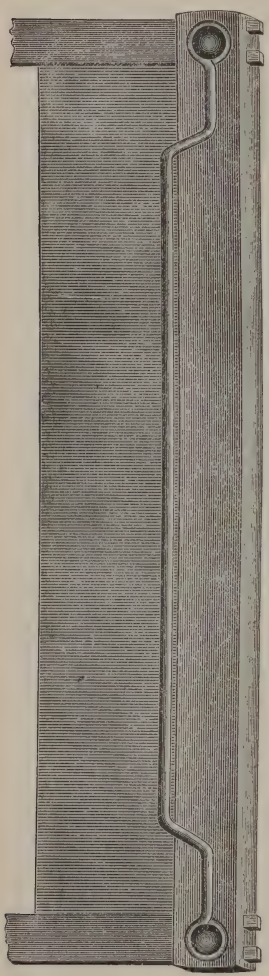
We have found it impossible to tabulate satisfactory information concerning loom dimensions, since there are so many measurements requisite to give a proper comprehension of the floor space demanded, position of driving pulleys, etc. We therefore supply blue prints to possible customers, which give the exact dimensions required.



KEENE DRAWING-IN FRAME.

We are introducing a drawing-in frame with attachments, especially designed for holding the warp, drop wire detectors, harness, and reed in a new and convenient manner, to assist the operative in drawing in a large number of warp ends in a given time. There has been some objection to the use of warp stop-motions in that they cause extra expense for drawing in; but this defect is largely obviated by this present invention. We make them in several widths. The parts are adjustable. The idea has been thoroughly tested in our own little weave room, and also by many of the mills using our looms. **We do not wish this device confused with automatic warp drawing-in machines.** It simply takes the place of the present frame for the same class of work.

SULLIVAN SHUTTLE GUARD.



These Shuttle Guards are made of the best quality coppered wire, five-sixteenths of an inch in diameter, and are long enough to reach the entire length of the hand-rail. An eye is formed in each end, and these eyes fit over the bolts which attach the hand-rail to the swords. No other fastening is required, except for certain widths of looms, when a center support is added. The guard fits closely to the hand-rail for about three inches at each end and is then bent to hang over the race in any position desired.

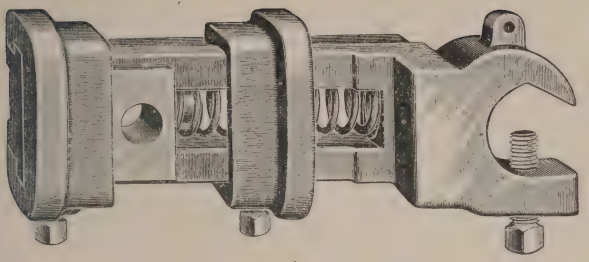
This form of construction and attachment makes the most simple and durable shuttle guard that has thus far been introduced.

The hand-rail is not cut or damaged in any way in making the attachment, nor are there any bolts, screws, or other fastening, such as have to be used with other guards, to work loose and annoy and hinder the weavers. In weaving extreme width goods on narrow looms, this guard has an advantage over others in having no bolt ends to project from back of hand-rail to tear or damage the harness.

This guard can be applied for repairs where it would otherwise be necessary to renew the hand-rail, at less than half the cost of making and fitting a new hand-rail. There are thousands of them in use.

DIRECTIONS FOR ORDERING.

Give length between centers of bolts that attach hand-rail to swords, and distance it is desired to have the guard project forward from face of hand-rail and down below centers of bolts, also if center supports are needed.



THE IMPROVED DURKIN THIN PLACE PREVENTER.

We applied thousands of these attachments to the old common looms before entering the loom field and since we have been building looms we have naturally neglected the improvement of competing structures. Those who wish to get the best results out of their old looms when weaving light goods can use them to great advantage. They lessen thin and thick places, lessen the results of shuttle smashes, lessen warp breakage and increase production. Every improvement that tends to lessen the breakage of warp threads is of high importance when endeavoring to increase the number of looms per operative. A slight extra cost at the start may pay for itself many times and not always receive due credit for the performance.

The construction consists of a pair of arms fastening to the usual bar across the loom which supports or forms the whip roll, and a roller held at its ends by the sliding bearings, noted in the cut by the open hole for the journal. Where Bartlett or Roper let-offs are in use the regular roll may be used without necessity for an additional warp roller.

In our first patterns there was difficulty at times in adjusting the tension of the spring to allow definite control of the movement of the whip roll. We have now overcome this trouble by using uniform spring tension and governing the movement by adjustable stops as shown. We make patterns to fit different styles of looms.

On our own Northrop looms we can use a device co-operating with our new let-off, which takes the place of the Durkin preventer. This, however, is not adaptable to looms of other makes.

SPECIFICATIONS FOR

APPLICATION OF DURKIN THICK AND THIN PLACE PREVENTERS.

Ordered by.....
Date.....
How many looms?.....
Builder of Looms.....
What kind of Let-off?.....
What is the distance between Loom sides?.....
If Friction Let-off, send sample Whip Roll Bracket and Whip Roll.....
If Bartlett Let-off, send sample Whip Roll.....

LOOM TEMPLES.

Temples are essential in modern weaving practice, to keep the cloth at the proper width during the process of weaving, to prevent extra strain on the selvage threads, and to prevent the warp from being drawn in, or condensed near the selvages by the drag of the filling. The strain on the warp is so great that it is impossible to keep the cloth at the temple as wide as the space occupied by the warp in the reed, but good temples and careful setting can keep the cloth as near this width as is usually necessary. The earliest inventions in this line consisted of two flat pieces of wood with points set in one end of each. These were tied by a cord after being adjusted to the width of the goods, and were moved forward from time to time by the weaver. The next improvement was the "jaw temple," so called, working on a similar principle, but made self-acting by the motion of the lay. The first practical rotary temple was invented and introduced in this country by Ira Draper. Even in its early development it allowed a weaver to run two looms instead of one. A rotating toothed wheel was used, turning on a vertical pivot. This temple was further improved by George Draper, and went into extensive use; in fact, it still continues in use to a limited extent. The next important improvement was the reciprocating temple, invented by Mr. Warren W. Dutcher and his brother, for whom the Dutcher Temple Company was named. Mr. Warren W. Dutcher continued improving both temples and the machinery for making them, so that this Company and its successor, Draper Company, has practically controlled the entire temple business of this country. The original designs have been greatly improved, and manufacturers have been educated up to a high standard of efficiency. A few yards of spoiled goods will easily convince

one that the best temples are the cheapest. We have made hundreds of styles of temples, endeavoring to meet the requirements of each particular style of goods, and we are glad at all times to send experts to study the particular problems as they arise. Our recent improvements are in the line of providing for effects of wear, preserving alignment of parts, preventing oil on cloth, and teeth marks in the cloth. We furnish convenient adjusting plates, which need never be moved after once being attached to the loom. All of our temple parts are interchangeable and the perfect foundry and tool work has elicited admiration from many sources. Many mills are satisfied with our older forms of temple, which we still continue to furnish them, having never tried our later models. We know our recent designs are more efficient, however, and therefore confine our catalogue illustrations to the present approved types.

SETTING TEMPLES.

When the reed beats in the filling, it also stretches the cloth at its point of contact with the reed, to the full width of the reed. The temple then holds this cloth, the width in the temples being determined by the distance the temple is from the fell of the cloth. The reciprocation of the temple allows it to be set much nearer the fell than would otherwise be possible, and careful setting will thus take advantage of all the possible width that the temple may hold, relieving the selvage ends from strain. The amount of reciprocation necessarily varies with the character of the goods. On light goods, less reciprocation is necessary than on heavy goods. In careful setting, the temple top is from 1-32 to 1-16 of an inch from the reed, when the reed is at its forward point. Any greater distance lessens the effective advantages of the temple as a mechanism.

Care must be taken of course, to see that all the parts of the temple are correctly fastened together. If heel screws are not tight, the temple may damage the reed. The reciprocation of the temple bar produces wear unless properly lubricated. If the temple heads get loose, the teeth on the rolls are liable to be damaged by pressing against the bar. Temples need cleaning, at intervals, like all other moving machinery.

TEMPLE ROLLS.

Since the roll is the effective element in the temple, its construction is of prime importance. We have many different styles to accommodate the great variety in cloth woven. Our

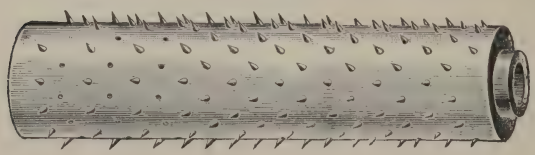
rolls are usually of two regular lengths, and we make other lengths by combining rolls of various lengths. The rolls usually have the same diameter for the outside tooth circle, the wood being turned in various diameters to allow the points of the teeth to project varying distances. On certain goods we use a taper setting, by which the teeth project farther at the selvage. In certain designs, we eliminate part of the teeth near the end of the roll. Our latest anti-friction style of roll uses wood bushings to run on gun-metal pins. The bushings are artificially treated to preserve their lubricant qualities. In our latest rolls and temples, the rolls cannot be put in wrong end foremost. With our old style rolls, run on a long roll pin, oil is necessary.

The illustrations do not show all of our rolls, or modifications, but they do show those which are most popular. In filling orders, we endeavor to select the rolls according to the cloth specified. If our customers choose for themselves, they, of course, assume the responsibility. Short rolls are 1 3-4″ long; long rolls 2 1-2″.

Our regular line of rolls is shown in the following list. It does not pretend to show every modification, however, as it is to be understood that these rolls are made with varying diameters, and each style of roll can be adapted for either style of bearing. We show the most used forms in the cuts. We usually select the rolls ourselves when filling temple orders, being guided by the cloth specified. Our customers may wish to choose for themselves, however, in which case, of course, our responsibility ends. The numbers have been changed from those given in some of our former catalogues.

LONG ROLLS.

No. 464.

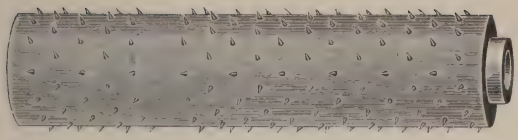


NAME—Eureka No. 1, small dia. roll, taper set, half number of teeth on selvage, wood bushings.

USE—This is a standard pattern for all medium grades of goods, 36 to 40 and above. Used regularly in our No. 76 temple.

VARIATIONS.—Also made with center hole for long bearing.
Also made large diameter.
Also made with full number of teeth on selvage.

No. 470.

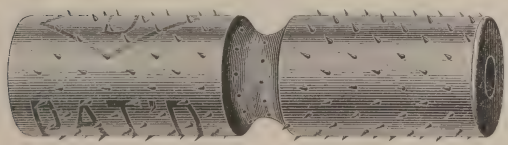


Like No. 464, but made with row of teeth omitted for use with wired pod as shown.

No. 410.

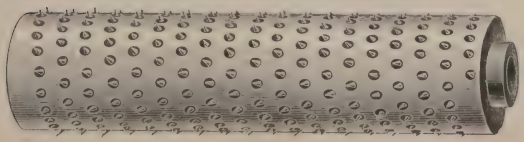
NAME—Eureka No. 1, grooved, small dia. roll, taper set, wood bushings.
USE—For ordinary sheetings or shirtings.
VARIATIONS—Also made with center hole for long bearing.
Also made large diameter.
Also made with half number of teeth on selvage.

No. 301.



NAME—Eureka No. 1, grooved, large dia. roll, long bearing.
USE—For fine sheetings and shirtings.
VARIATIONS—Also made with wood bushings.
Also made small diameter.

No. 364.



NAME—Special Eureka No. 1, roll. Large diameter with double number teeth taper set, wood bushing.
USE—For very fine goods.
VARIATIONS—Also made with long bearing.

SHORT ROLLS.

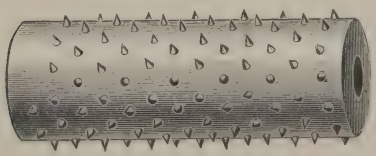
No. 120.

NAME—Small dia. roll, taper set, half number teeth on selvage, wood bushings.
USE—For narrow goods.
VARIATIONS—Also made for long bearing, as in No. 119 below.

No. 119.

Also made large diameter.
Also made with full number of teeth on selvage.

No. 101.

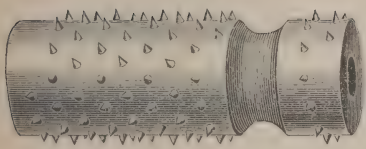


NAME—Common, small dia. roll, long bearing.
USE—For prints, etc.
VARIATIONS—Also made with wood bushings.
Also made large diameter, as in No. 1 on next page.

No. 1.

DOUBLE ROLL.

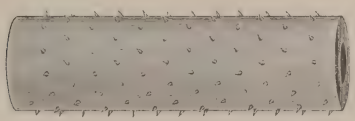
No. 105.



No. 101.

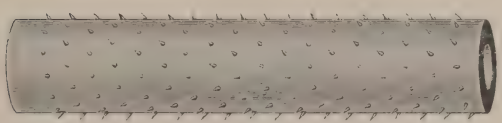
NAME—No. 2 small double roll.
USE—For very heavy or very wide goods with No. 84 or No. 85 temple.

No. 604.



NAME—Small 1-2 inch dia. roll for No. 107 temple.
This style uses two of this roll No. 604 and two of roll No. 602 with each temple.

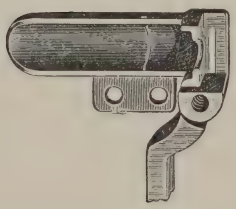
No. 602.



NAME—Small 1-2 inch dia. roll of longer pattern for Nos. 107 and 108 temple.
Two used with each temple.

All temple rolls manufactured by the Draper Co. are marked with their trade-mark, which has been established by years of use and duly registered at the Patent Office, together with the statement:

"For Use Only in Temples Made by the Draper Company."



One of our present temple improvements consists in the application of the Stimpson Patent wire to the pod of the bar as shown, which acts against a blank space on the roll where the teeth are omitted to assist in holding the cloth against the roll and insure the penetration of the teeth in the fabric. By distributing the pressure on a large number of teeth, it assists materially in preventing temple marks.

Apart from the roll, the rest of the temple varies in form to suit the customer. Some mills prefer spring temples, and others hinge temples. Hinge temples cannot be used on Northrop Looms of our make. The regular reciprocating styles Number 76 or 78, have been most popular, but styles 150 and 151 present important improvements.

Many mills persistently order old styles of temples, which we do not now recommend. We can, of course, supply them, but there is no reason why the mill should handicap itself in this way. Wear, repairs and **effects** are all strongly in favor of the recent patterns.

In ordering, note carefully the specification below. We have so many styles that it is necessary when ordering temples of old patterns, or repair parts for same, to send samples.

SPECIFICATIONS FOR DUTCHER'S PATENT TEMPLES

ORDERED FROM DRAPER COMPANY,
HOPEDALE, MASS.

Name .....
Date .....19 .....
Place .....
Ship to .....
Via what route .....
How many Looms to be fitted .....
What make of Loom .....
What kind of cloth to be woven .....
Width of cloth .....
Please send sample piece of cloth, not less than 6 or 8 inches on the selvage.
How many Right Hand Temples required .....
How many Left Hand Temples required .....
What kind of Temple .....
Is the breast beam iron or wood .....
What is width of breast beam .....
What width is (lay) race board: i. e., from front of reed to front of lay .....
What is the distance from front of lay to breast beam when at point nearest together .....
How high is top of breast beam above race board of lay .....

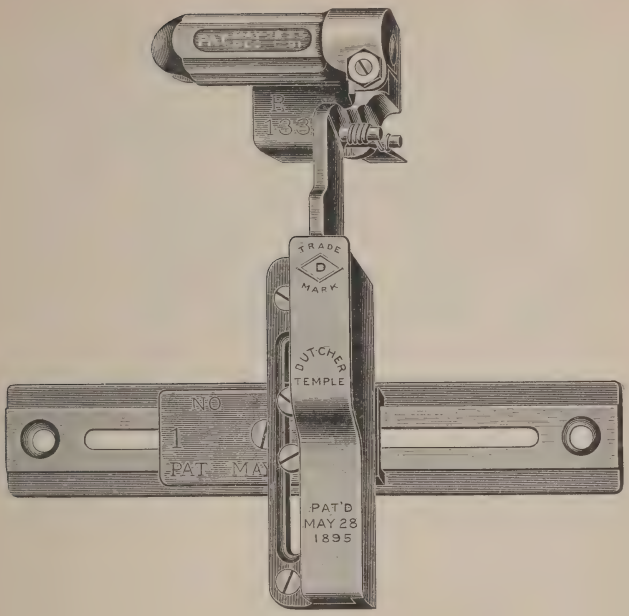
NAMES OF PRESENT STANDARD PATTERNS SOME OF WHICH ARE SHOWN IN FOLLOWING PAGES.

No. 133 Dutcher Thread-Cutting Temple.
No. 76 and 76 1-2 Dutcher Thread-Cutting Temple.
No. 78 and 78 1-2 Dutcher Thread-Cutting Temple.
No. 103 Dutcher Thread-Cutting Temple.
No. 104 Dutcher Thread-Cutting Temple.
No. 111 Dutcher Thread-Cutting Temple.
No. 113 Dutcher Thread-Cutting Temple.
No. 76 and 76 1-2 Dutcher Temple.
No. 78 and 78 1-2 Dutcher Temple.
Dutcher Hinge Temple, 1894 pattern.
No. 87 Dutcher Spring Temple.
No. 88 Dutcher Spring Temple.
No. 89 Dutcher Spring Temple.
No. 82 Dutcher Temple.
No. 84 Dutcher Temple.
No. 85 Dutcher Temple.
No. 100 Dutcher Gingham Temple.
No. 107 Dutcher Temple.
No. 108 Dutcher Temple.
No. 131 Dutcher Temple.
No. 150 Dutcher Hump cap Temple.
No. 151 Dutcher Hump cap Temple.
No. 118 Dutcher Corduroy Temple.
No. 132 Dutcher Corduroy Temple.
Hardaker Patent Temple.
Knowles Patent Temple.
Dawson Patent Temple.

The first nine are fitted with either wood bushed rolls or center bearing as desired. Nos. 82, 84, 85, 107 and 108 always have long center bearing.

TEMPLES FOR NORTHROP LOOMS.

Our earlier patterns of loom, made without the high roll take-up, use regular temples No. 76, 76 1-2, 78 and 78 1-2 with thread-cutting temples on the hopper side. The temples used with the high roll take-up have parts similar in purpose to those of the former patterns, but some of them are necessarily different in shape.



PRESENT MODEL OF THREAD-CUTTING TEMPLE FOR NORTHROP LOOMS—NO. 133.

(Shown with Honan Plate.)

This model is made with extra capacity to retract so as to weave in a shuttle in front without damage. It has the modern hump cap, and a bar and heel in one piece which prevents the common troubles due to heels coming loose.

TECHNICAL NAMES OF PARTS.

1. Bar and heel.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Base Plate.
7. Honan Plate Slide.
8. Plate Bolt, Nut and Washer for Iron Beams.
9. Plate Screw for Wood Beams.
10. Roll pin for outer end of Thread-Cutting Temple.
11. Roll pin for inner end.
12. Slide Screw and Nut.
13. Cap Screw.
14. Stand Screw.
15. Top Screw.
16. Roll.
17. Bolt, Nut and Washer for Northrop base plate.
18. Northrop loom temple Slide.
19. Knife.
20. Cutter Spring.

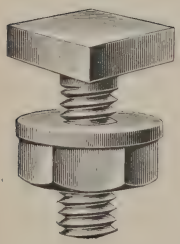
Parts 5, 6, 7 and 16 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as "*Left Bar for No. 133 Temple.*"

Parts 1, 2, 3, 5 and 7 are made rights and lefts.

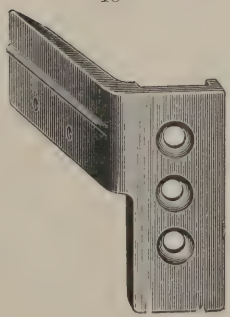
Parts 1 to 7 and 19 are shown one-third size.

Other parts are shown full size.

17



18



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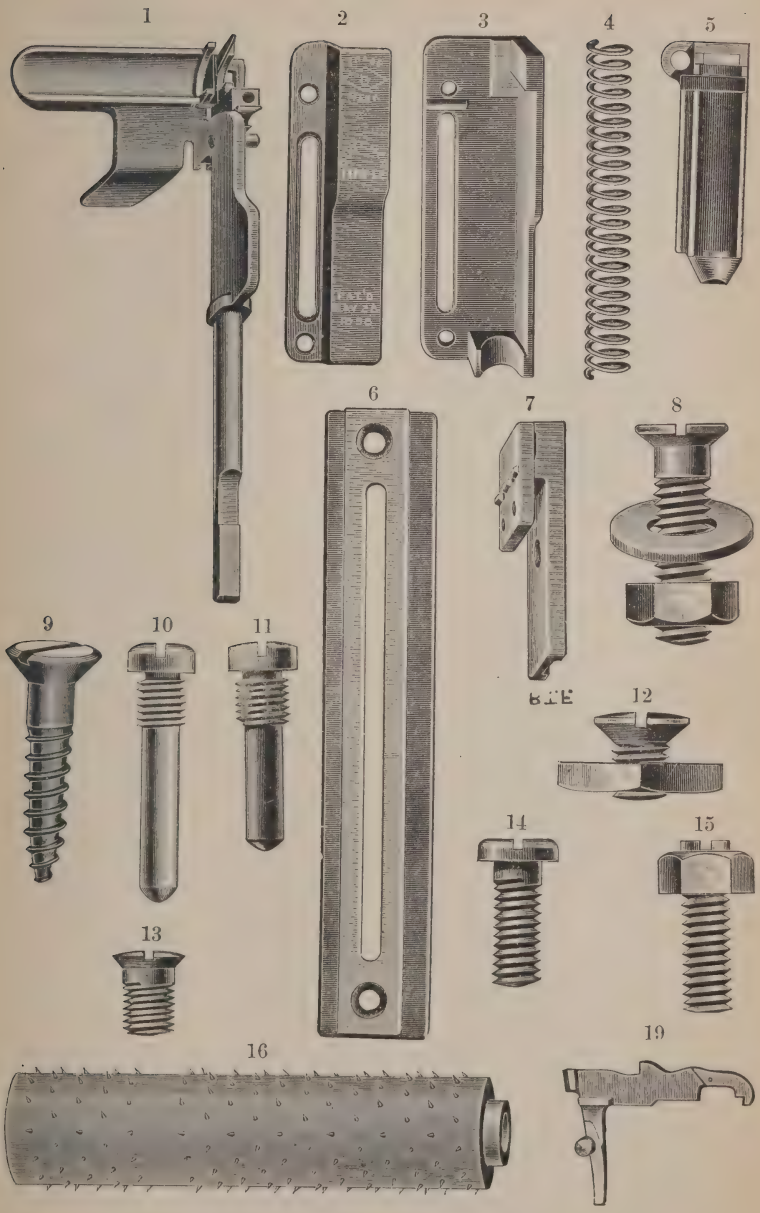
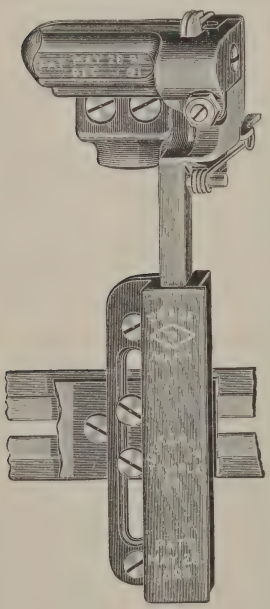


PARTS OF NO. 133 TEMPLE.

NOS. 76, 76 1-2, 78 AND 78 1-2 THREAD-CUTTING TEMPLE WITH HONAN PLATE.

TECHNICAL NAMES OF PARTS.

Nos. 76 1-2 and 78 1-2 Thread-Cutting Temples have longer bars than Nos. 76 and 78. None of these numbers apply to temples used on later forms of Northrop Looms having the High Roll Take-Up. Those are numbered Nos. 103-104, and for a heavy model loom are numbered 111 and 113. Our latest looms take number 133.



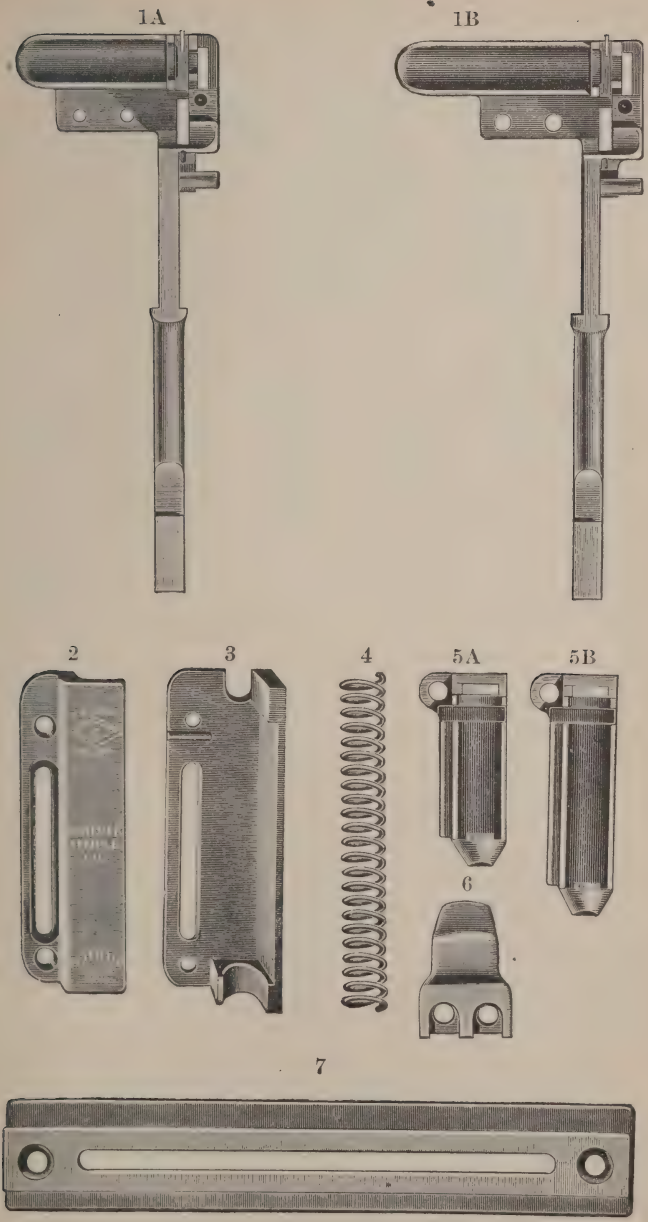
1A. Bar for 78 Thread-Cutting Temple.
1B. Bar for 76 Thread-Cutting Temple.
2. Cap.
3. Stand.
4. Spring.
5A. Top for 78 Thread-Cutting Temple.
5B. Top for 76 Thread-Cutting Temple.
6. Heel.
7. Base Plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Breast Beam.
10. Plate Screw for Wood Beam.
11A. Roll Pin for outer end of Thread-Cutting Temple.
11. Roll Pin for inner end of Thread-Cutting Temple.
12. Top Screw.
13. Stand Screw
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Roll for 78 Temple. } Send
18. Roll for 76 Temple. } sample.
19. Cutter Spring.
20. Knife.

Parts 5, 6, 7, 8, 17 and 18 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list as "*Left Bar for No. 78 Thread-Cutting Temple.*"

Parts 1, 2, 3, 5, 8, 19 and 20 are made rights and lefts.

Parts 1 to 8 are shown one-third size.

Parts 9 to 20 are shown full size.



PARTS OF NO. 76 AND 78 THREAD CUTTING TEMPLE.

NOS. 76, 76 1-2, 78 AND 78 1-2 THREAD-CUTTING TEMPLE. (CONTINUED.)

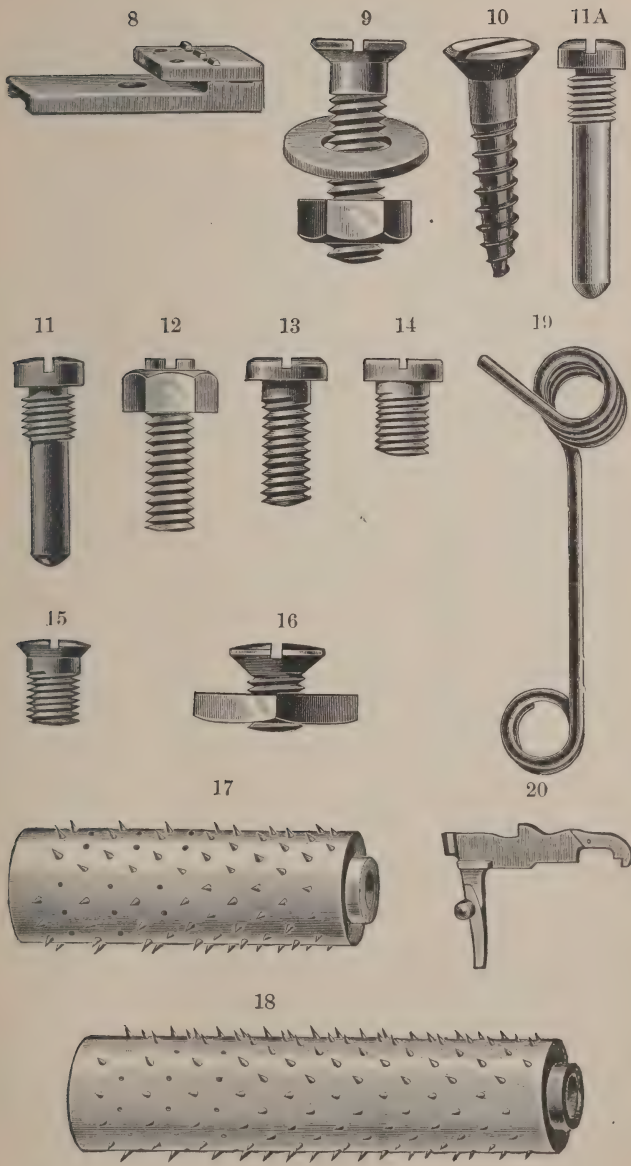
TECHNICAL NAMES OF PARTS ON OPPOSITE PAGE.

8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Breast Beam.
10. Plate Screw for Wood Beam.
11A. Roll Pin for outer end of Thread-Cutting Temple.
11. Roll Pin for inner end of Thread-Cutting Temple.
12. Top Screw for Thread-Cutting Temple.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Roll for 78 Temple.
18. Roll for 76 Temple.
19. Cutter Spring.
20. Knife.

TEMPLES FOR HIGH ROLL TAKE-UP NORTHROP LOOMS.

Nos. 103 and 104 have the same parts as these shown so far as function and general appearance are concerned. We therefore have not thought it necessary to illustrate them.

Same applies to Nos. 111 and 113.


8
9
10
11A
11
12
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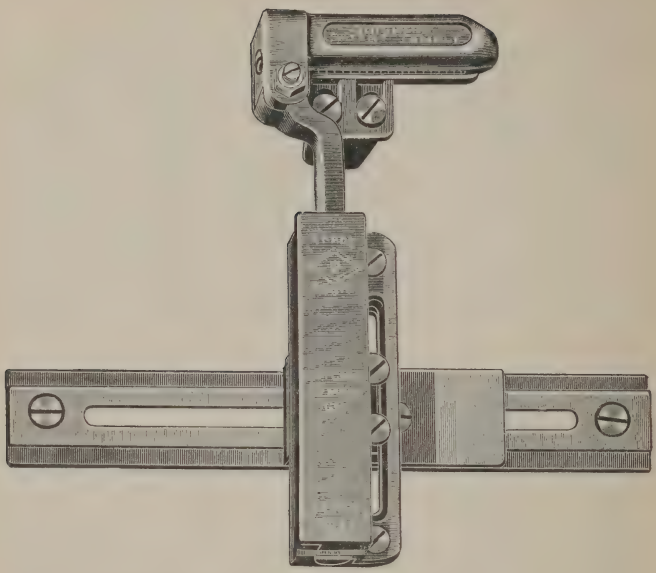
18



DUTCHER PATENT NO. 76 AND 76 1-2 TEMPLE.

(Shown with Honan Plate. Can be had without, but the Honan is best.)

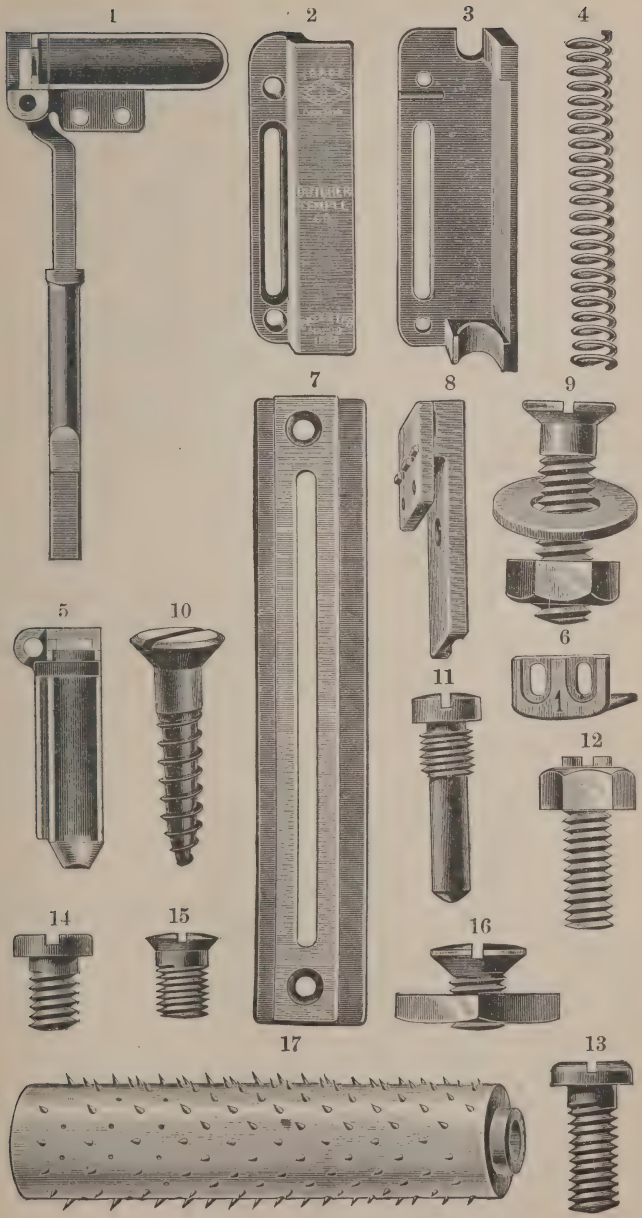
Dutcher Patent No. 76½ Temple has similar parts to No. 76, except that the bar is longer, which makes it especially adaptable for looms with a wide shuttle so that the shuttle can weave in.

TECHNICAL NAMES OF PARTS.

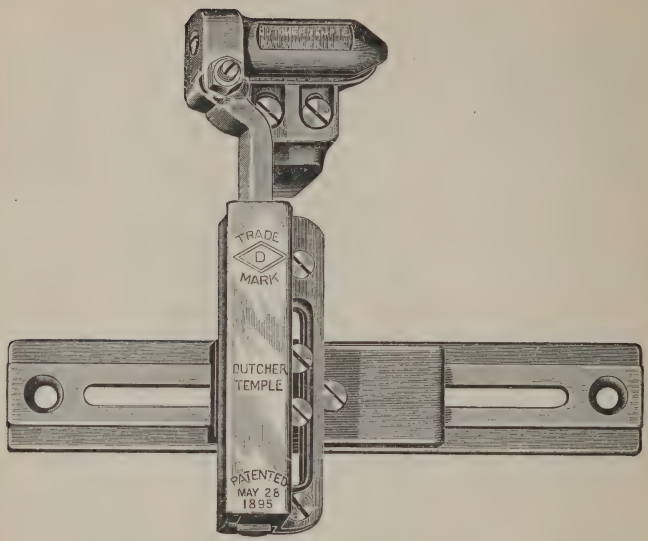
1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Base Plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Beam.
10. Plate Screw for Wood Beam.
11. Roll Pin.
12. Top Screw.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Roll.

Parts 5, 6, 7, 8 and 17 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as "*Left Bar for No. 76 Temple.*"

Parts 1, 2, 3, 5 and 8 are made rights and lefts.
Parts 1 to 8 are shown one-third size.
Parts 9 to 17 are shown full size.



PARTS OF NO. 76 and 76½ TEMPLE.



DUTCHER PATENT NO. 78 AND 78 1-2 TEMPLE.

(Shown with Honan Plate. Can be had without, but the Honan is best.)

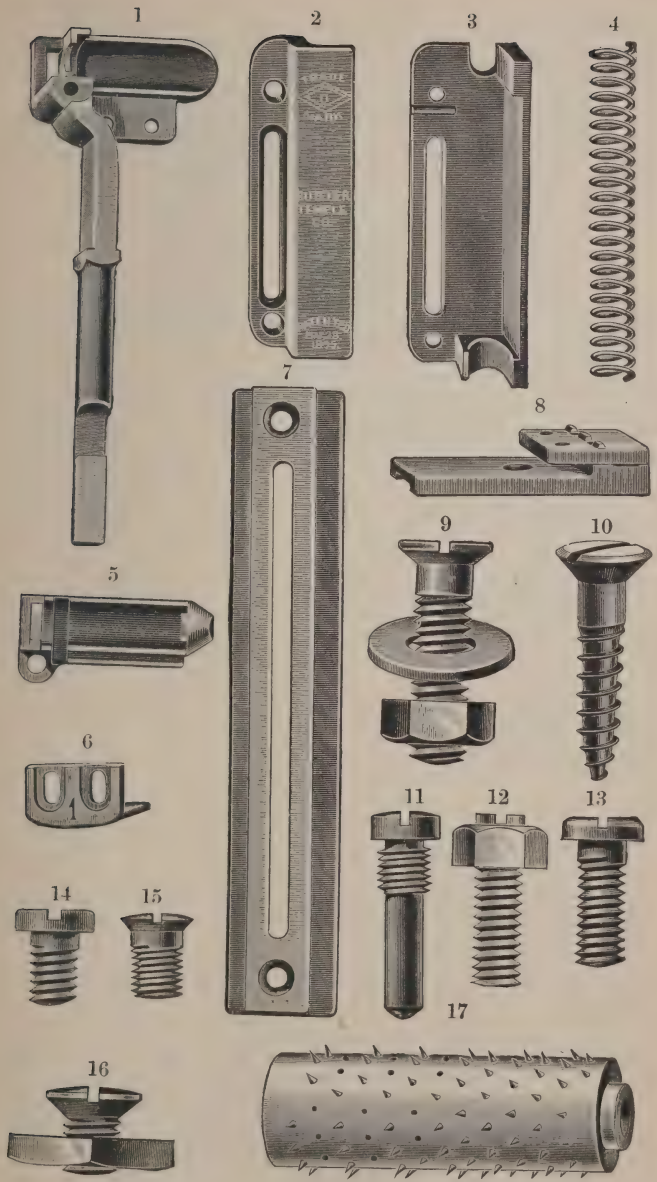
Dutcher Patent No. 78½ Temple has similar parts to No. 78, except that the bar is longer, which makes it especially adaptable for looms with a wide shuttle.

TECHNICAL NAMES OF PARTS.

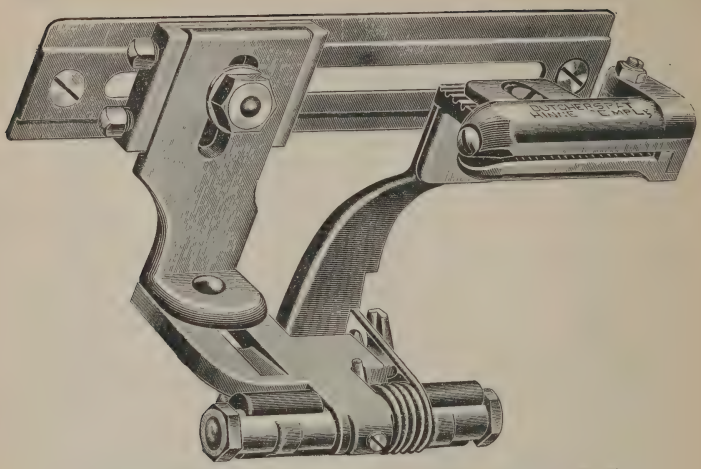
1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Base Plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Beam.
10. Plate Screw for Wood Beam.
11. Roll Pin.
12. Top Screw.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Roll.

Parts 5, 6, 7, 8 and 17 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list as "*Left Bar for No. 78 Temple.*"

Parts 1, 2, 3, 5 and 8 are made rights and lefts.
Parts 1 to 8 are shown one-third size.
Parts 9 to 17 are shown full size.



PARTS OF DUTCHER NO. 78 and 78½ TEMPLE.



DUTCHER PATENT HINGE TEMPLE, 1894 PATTERNS.

TECHNICAL NAMES.

1. Swing.
2. Base Plate.
3. Extension.
4. Stand.
5. Extension Pin.
6. Slide.
7. Pod.
8. Top.
9. Spring.
10. Heel.
11. Roll.
12. Nut for Extension Pin.
13. Bearing.
14. Stand Bolt, nut and washer.
15. Stand Screw and Washer.
16. Bolt, Nut and Washer for Iron Breast Beam.
17. Screw for Wood Breast Beam.
18. Roll Pin.
19. Top Screw.
20. Slide Screw.
21. Pod Bolt and Nut.
22. Extension Pin Screw.
23. Heel Screw.

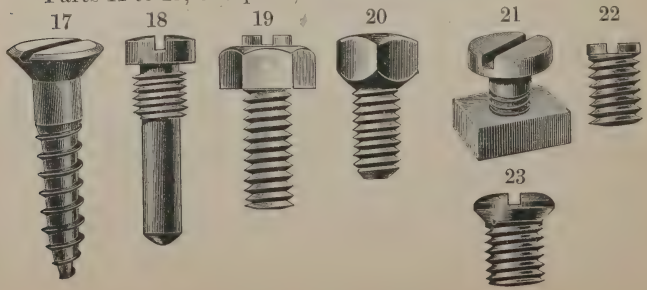
Parts 1, 2, 3, 4, 7, 8, 9, 10 and 11 are made in different shapes and sizes. They must be ordered by sample or by number on pattern.

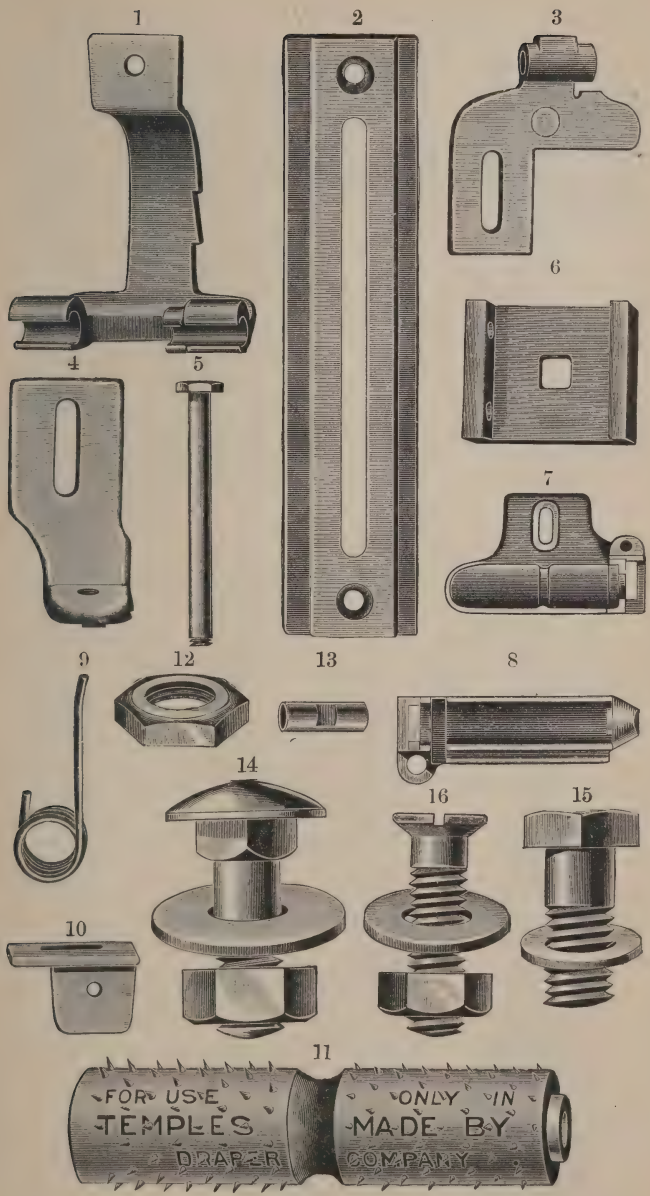
The rest can be ordered by this list as, "*Bearing for 1894 Hinge Temple.*"

Specify Rights and Lefts when necessary.

Parts 1 to 10 and 13 are shown one-third size.

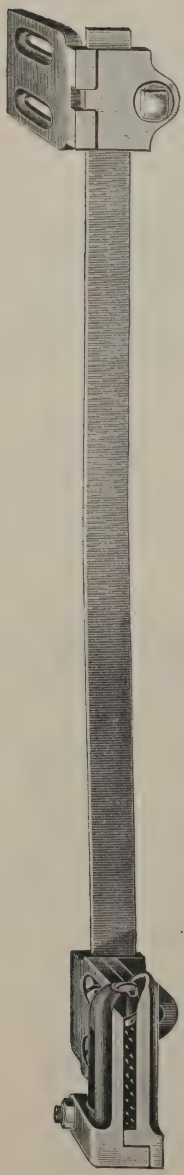
Parts 11 to 23, except 13, are shown full size.





PARTS OF DUTCHER HINGE TEMPLE, 1894 PATTERN.

DUTCHER PATENT SPRING TEMPLE NO. 87.



Also made in styles Nos. 88 and 89, distinguished by different lengths of heel.

PATENTED MAY 28, 1895.

Spring 17 inches long with 1 inch offset unless otherwise specified.

Face plates to carry spring forward from 3-4 to 1 3-4 inches.

TECHNICAL NAMES OF PARTS.

1. Spring.
2. Face Plate.
3. Top Plate.
4. Pod.
5. Top.
6. Heel and Plate Clamp.
7. Heel.
8. Face Plate Screw and Washer.
9. Top Plate Screw.
10. Roll Pin.
11. Plate Clamp Screw and Washer.
12. Top Screw.
13. Heel Screw.
14. Plate Bolt, Nut and Washer for Iron Breast Beam.
15. Roll.

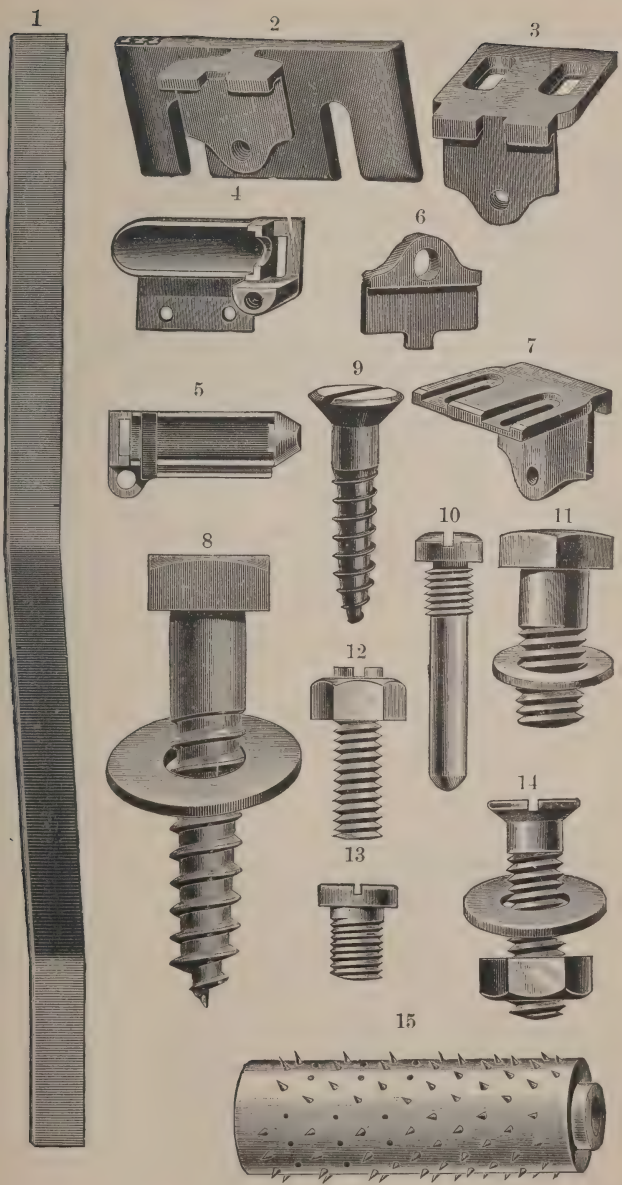
Parts 1, 4, 5, 7 and 15 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as, "*Face Plate for 87 Spring Temple.*"

Parts 4 and 5 made in rights and lefts.

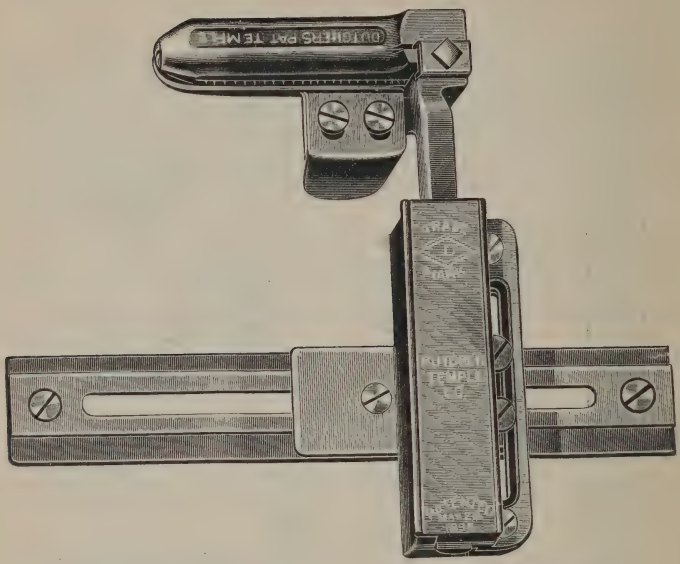
Parts 1—7 shown 1-3 size.

Parts 8—15 shown full size.

Also made with long roll.



PARTS OF DUTCHER PATENT SPRING TEMPLE NO. 87.



DUTCHER NO. 82, 84, OR 85 TEMPLE.

(Shown on Honan Plate.)

No. 82 has bar 8 inches long.
No. 84 has bar 9 inches long.
No. 85 has bar 10 inches long.

TECHNICAL NAMES OF PARTS.

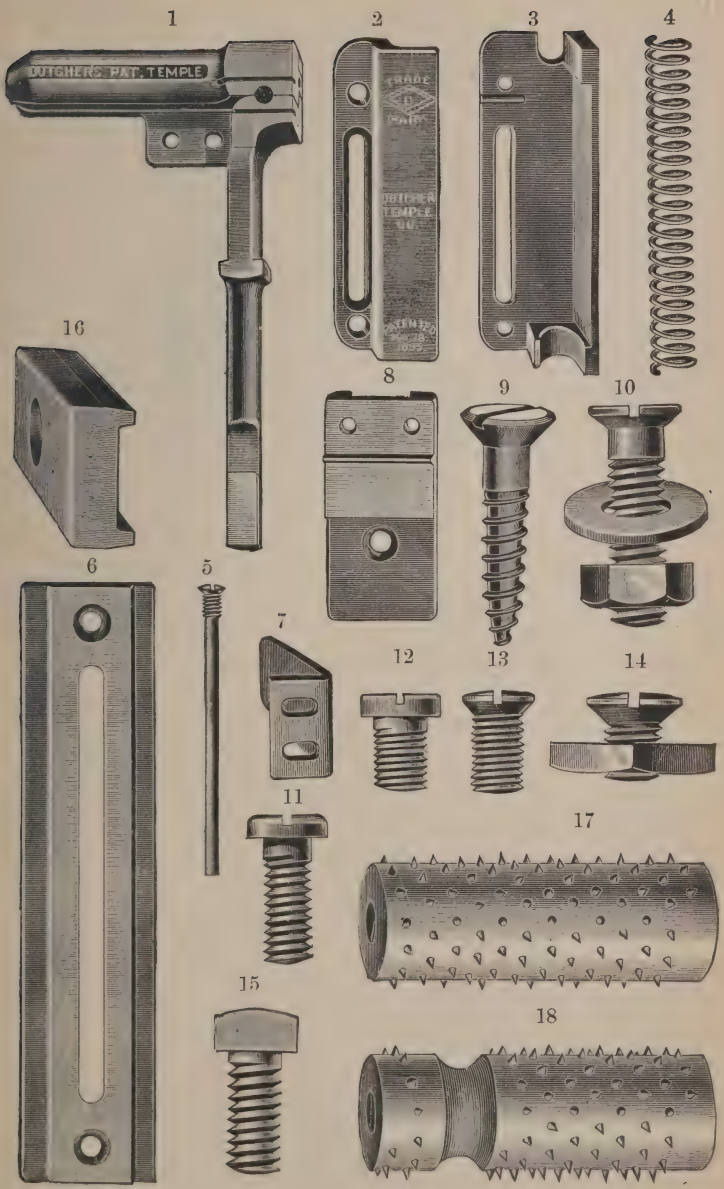
1. Bar and Top.
2. Cap.
3. Stand.
4. Spring.
5. Roll Pin.
6. Base Plate.
7. Heel.
8. Slide.
9. Plate Screw for Wood Beam.
10. Plate Bolt, Nut and Washer for Iron Beam.
11. Stand Screw.
12. Heel Screw.
13. Cap Screw.
14. Slide Screw and Nut.
15. Top Screw.
16. Top Screw Lock.
17. Inner Roll.
18. Selvage Roll.

Parts 1, 6, 7, 8, 17 and 18 are made in different shapes and sizes and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as "*Stand for left hand, No. 84 Temple.*"

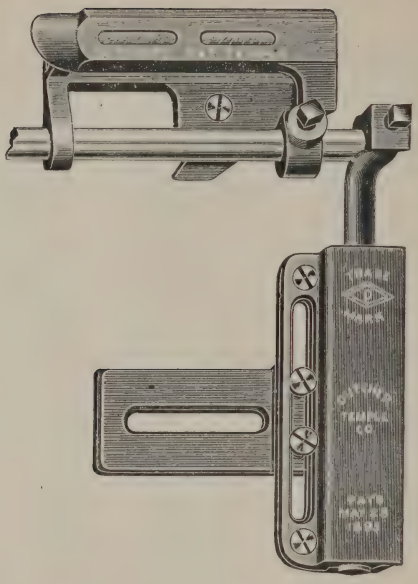
Parts 1, 2, 3 and 8 are made rights and lefts.

Parts No. 1 to 8 shown one-third size.

Parts 9 to 18 shown full size.



PARTS OF NO. 84 OR 85 TEMPLE.



DUTCHER PATENT TEMPLE NO. 100 FOR GINGHAM LOOMS.

TECHNICAL NAMES OF PARTS.

1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Plate.
8. Pod.
9. Rod.
10. Plate Screw for Wood Beam.
11. Roll Pin.
12. Top Screw.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Inner Roll.
17. Outer Roll.

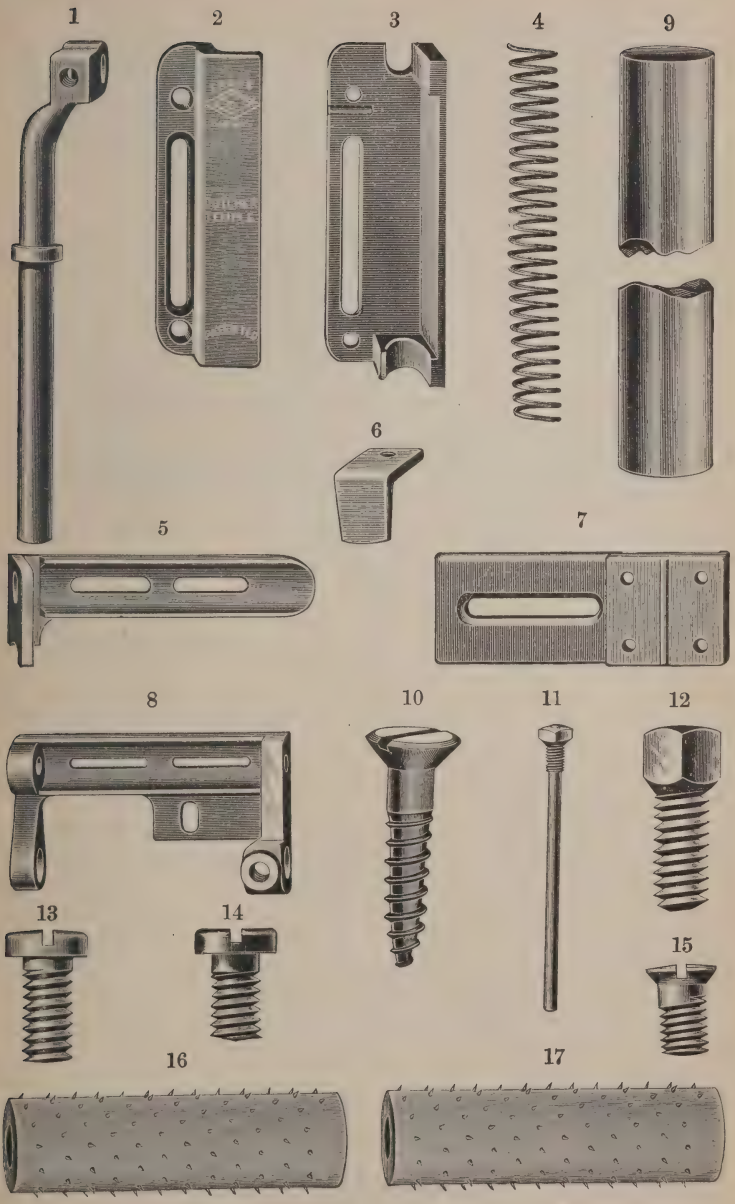
Parts 6, 7, 9, 16 and 17 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list as "*Left Bar for No. 100 Temple.*"

Parts 1, 2, 3, 5, 7 and 8 are made rights and lefts.

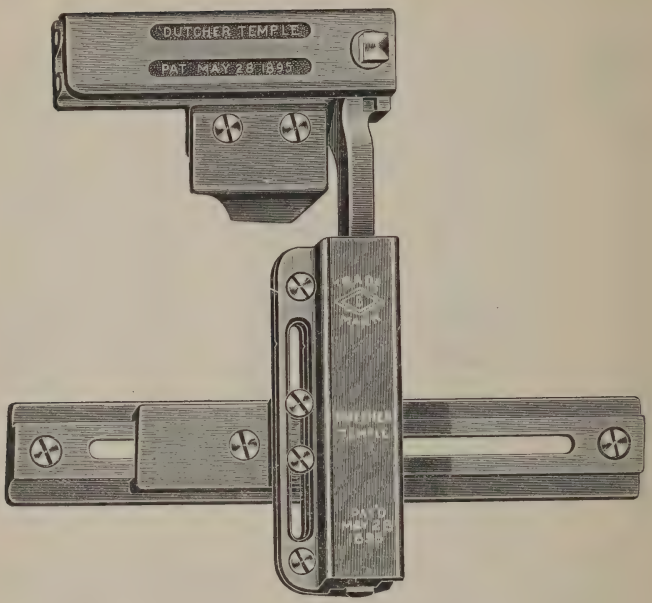
Parts 1 to 8 and 11 are shown one-third size.

Parts 9 to 17 (except 11) are shown full size.

This temple is usually applied to wooden breast-beams. If made for iron beams it would have Plate Slide and Plate Bolt like other varieties shown.



PARTS OF DUTCHER GINGHAM TEMPLE.



DUTCHER PATENT NO. 107 TEMPLE.

Shown on Honan Plate.

For any fine goods or difficult weaves.

TECHNICAL NAMES OF PARTS.

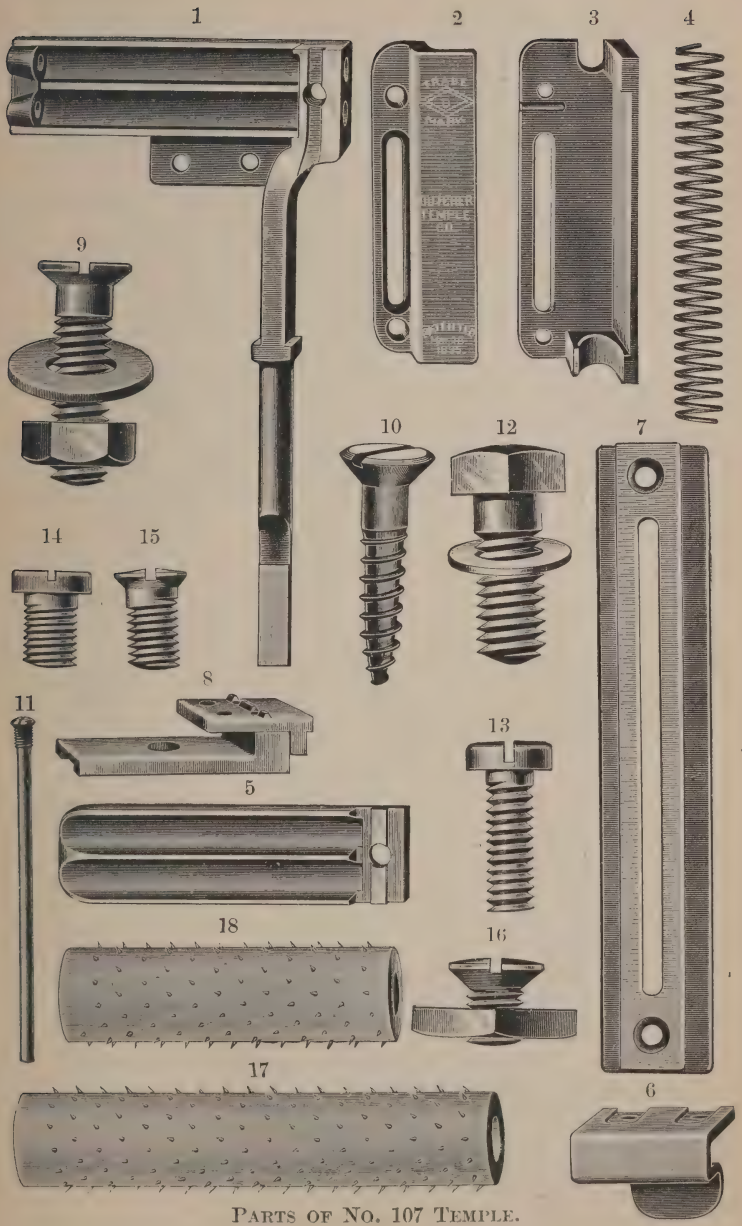
1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Base Plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Beam.
10. Plate Screw for Wood Beam.
11. Roll Pin.
12. Top Screw and Washer.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Long Roll.
18. Short Roll.

Parts 6, 7, 8, 17 and 18 are made in different shapes and sizes and must be ordered by sample or by number on pattern. The rest can be ordered by this list as "*Left Top for No. 107 Temple.*"

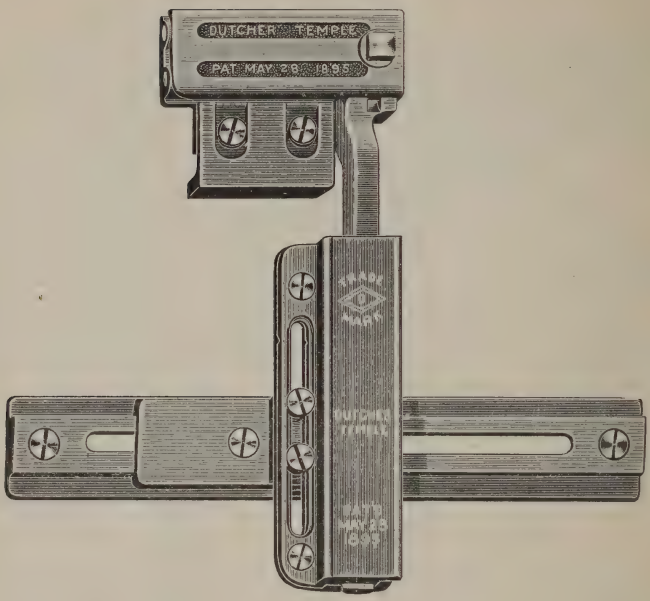
Parts 1, 2, 3, 5 and 8 are made rights and lefts.

Parts 1 to 8 and 11 are shown one-third size.

Parts 9 to 18 (except 11) are shown full size.



PARTS OF NO. 107 TEMPLE.



DUTCHER PATENT NO. 108 TEMPLE.

Shown on Honan Plate.

Specially adapted for fine goods and difficult weaves.

TECHNICAL NAMES OF PARTS.

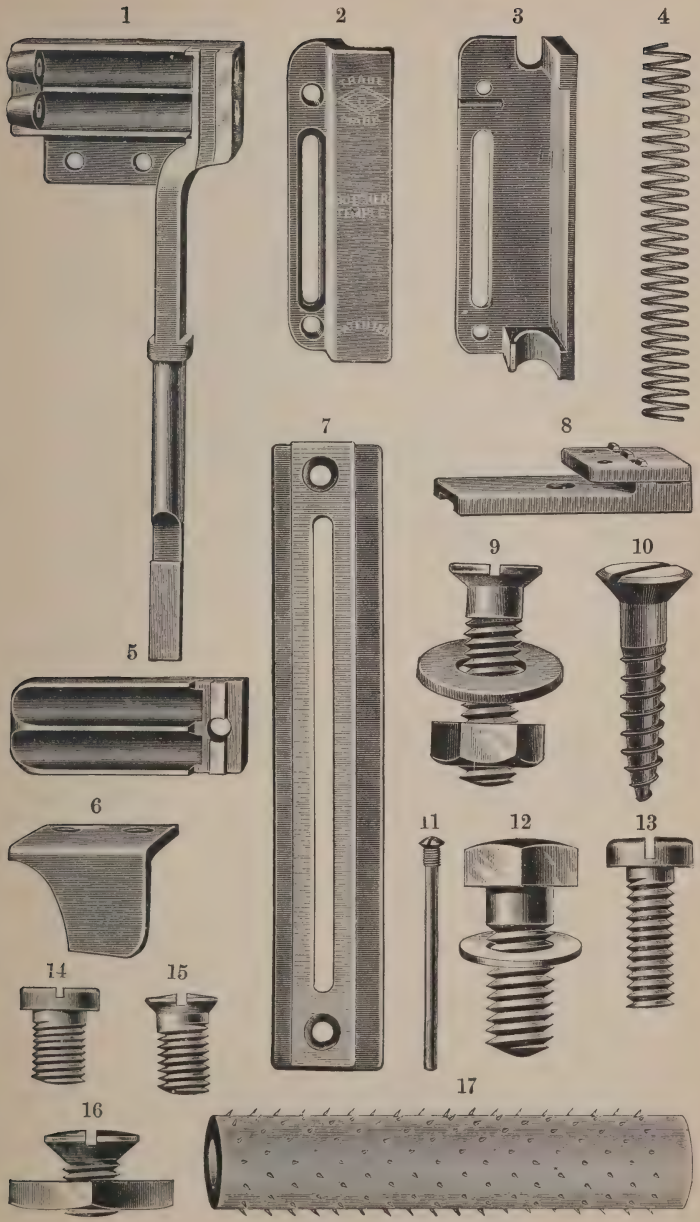
1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Base Plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Beam.
10. Plate Screw for Wood Beam.
11. Roll Pin.
12. Top Screw and Washer.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Roll.

Parts 6, 7, 8 and 17 are made in different shapes and sizes and must be ordered by sample or by number on pattern. The rest can be ordered by this list as "*Left Top for No. 108 Temple.*"

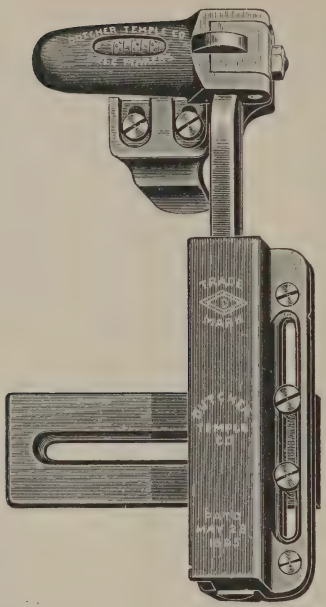
Parts 1, 2, 3, 5 and 8 are made rights and lefts.

Parts 1 to 8 and 11 are shown one-third size.

Parts 9 to 17 (except 11) are shown full size.



PARTS OF NO. 108 TEMPLE.



DUTCHER PATENT NO. 131 TEMPLE.

TECHNICAL NAMES OF PARTS.

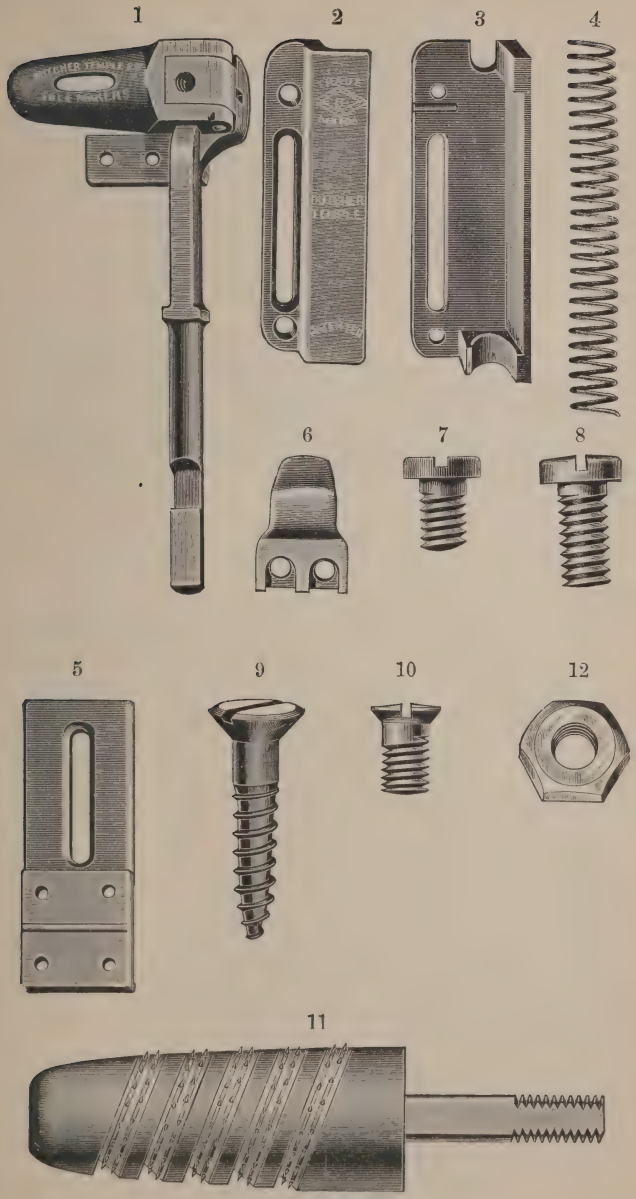
1. Bar and Top.
2. Cap.
3. Stand.
4. Spring.
5. Plate.
6. Heel.
7. Heel Screw.
8. Stand Screw.
9. Plate Screw for Wood [Beam.
10. Cap Screw.
11. Roll.
12. Roll Nut.

Parts 5 and 6 are made in different shapes and sizes and must be ordered by sample or by number on pattern. The rest can be ordered by this list as "*Roll Nut for No. 131 Temple.*"

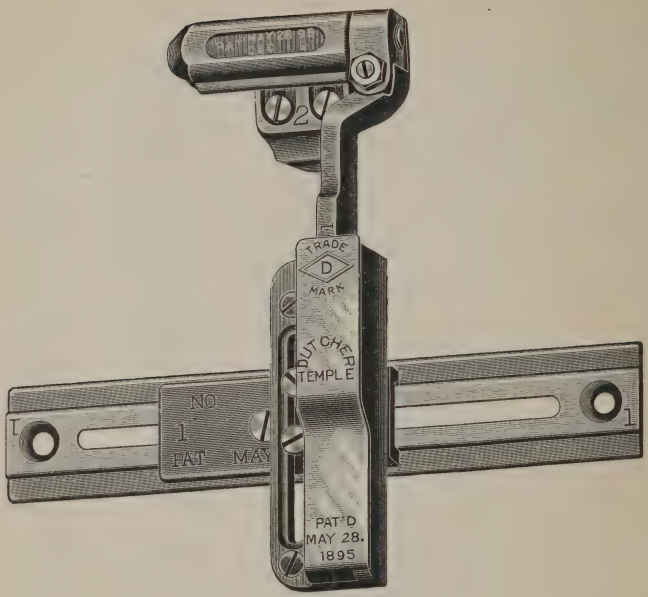
Parts 1, 2 and 3 are made rights and lefts.

Parts 1 to 6 are shown one-third size.

Parts 7 to 12 are shown full size.



PARTS OF NO. 131 TEMPLE.



DUTCHER PATENT NO. 150 AND 151 TEMPLE.

(Shown with Honan Plate. Can be had without, but the Honan is best.)

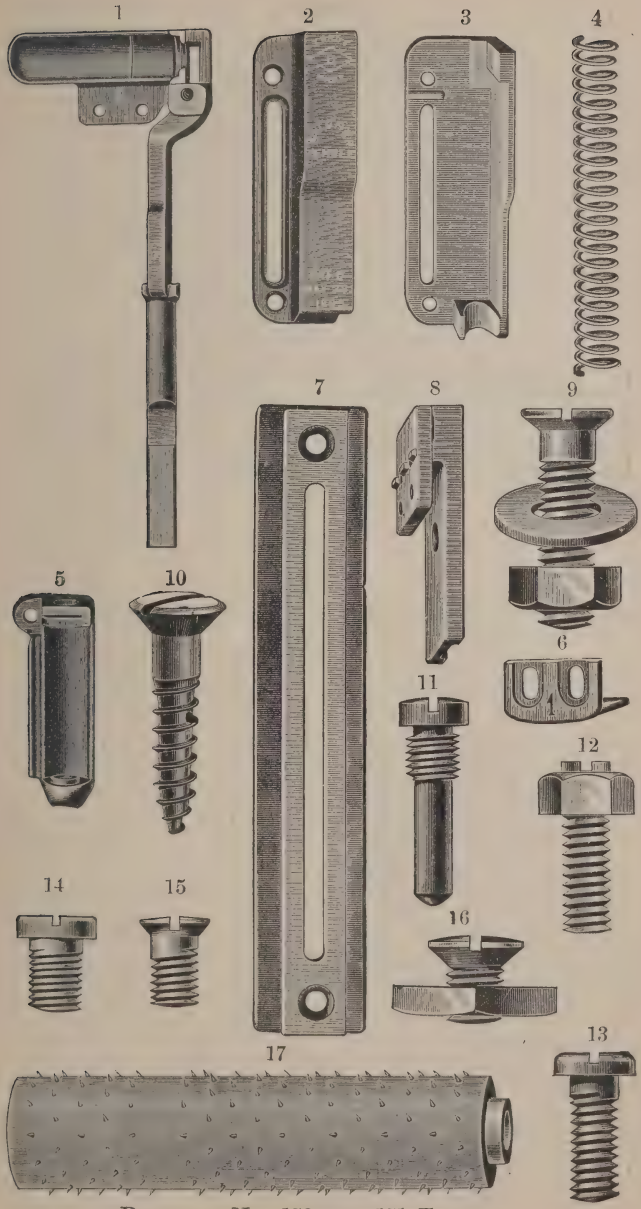
Dutcher Patent 151 Temple has similar parts to No. 150 except that the bar is longer, which makes it especially adaptable for looms with wooden breast beams.

TECHNICAL NAMES OF PARTS.

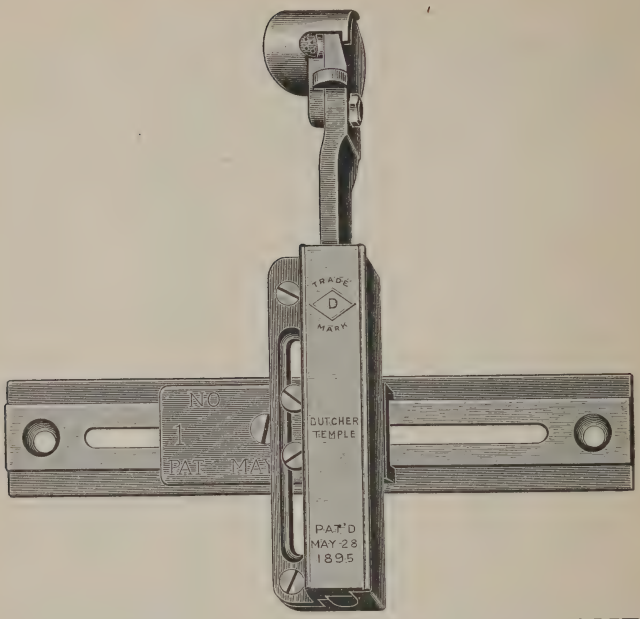
1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Base plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Beam.
10. Plate Screw for Wood Beam.
11. Roll Pin.
12. Top Screw and Check Nut.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Roll.

Parts 5, 6, 7, 8 and 17 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as "*Left Bar for No. 150 Temple.*"

Parts 1, 2, 3, 5 and 8 are made rights and lefts.
Parts 1 to 8 are shown one-third size.
Parts 9 to 17 are shown full size.



PARTS OF NO. 150 AND 151 TEMPLE.



DUTCHER PATENT NO. 118 AND 132 TEMPLE.

(Shown with Honan Plate. Can be had without, but the Honan is best.)

A selvage temple for corduroys and velvets that has met with marked favor. We first used this pattern on our Northrop loom and it was soon demanded by users of common looms who noted its advantages.

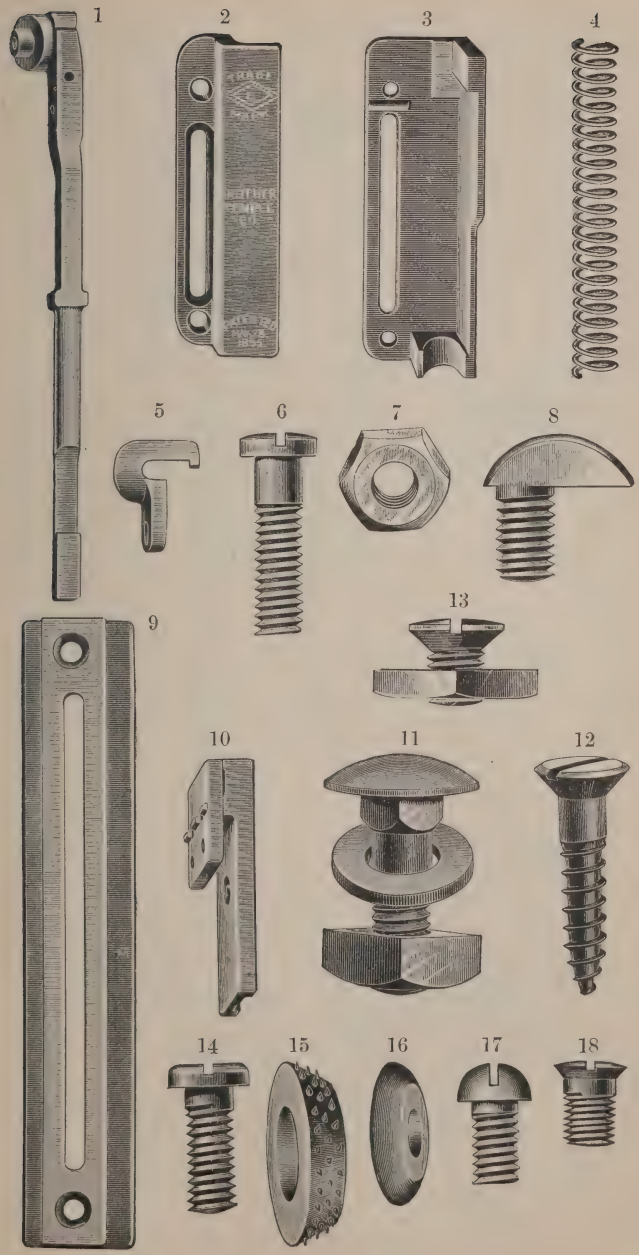
Dutcher Patent No. 118 is the number given the above temple when used with Northrop Looms. The right hand temple then has a thread-cutter. No. 132 is the number when used on a common loom.

TECHNICAL NAMES OF PARTS.

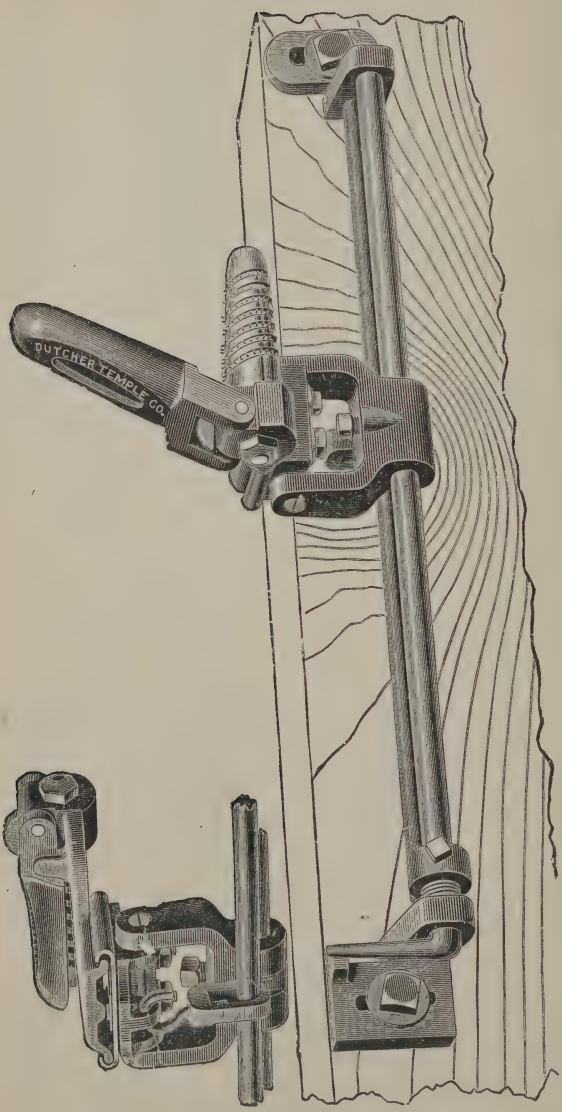
1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Top Screw.
7. Check Nut.
8. Lock Screw.
9. Base Plate.
10. Honan Plate Slide.
11. Plate Bolt, Nut and Washer for Iron Beam.
12. Plate Screw for Wood Beam.
13. Slide Screw and Nut.
14. Stand Screw.
15. Roll.
16. Roll Washer.
17. Roll Screw.
18. Cap Screw.

Parts 9 and 18 are made in different shapes and sizes, and must be ordered by sample, or by number on pattern. The rest can be ordered by this list, as "*Left Bar for No. 132 Temple.*"

Parts 1, 2, 3, 5 and 10 are made rights and lefts.
Parts 1 to 5 and 9 to 10 are shown one-third size.
Parts 2 to 4, 6 to 8 and 11 to 18 are shown full size.



PARTS OF NO. 118 AND 132 TEMPLE.



HARDAKER'S PATENT TEMPLE FOR WOOLEN AND WORSTED FABRICS.

HARDAKER'S PATENT TEMPLE FOR WOOLEN AND WORSTED FABRICS.

In weaving the heavier kinds of woolen and worsted goods, there is in almost all looms a considerable horizontal and vertical movement of the cloth; and the temple that offers no resistance to these movements other than the trifling one of its own weight, has the greatest merit. It must also be self-acting.

Until the invention of Mr. Hardaker, there was great difficulty in templing heavy and broad cloths in a self-acting manner. It is of the utmost importance to have the temple roll as close to the front of the shed as possible. Sometimes the beat of the reed will move the cloth horizontally an inch or more; and if the temple is rigidly mounted, a distance exceeding this movement must be allowed between the front of the shed and the roll. When the reed recedes, the front of the shed follows it for some distance, and the cloth must also pass or rub back over the roll, and this rubbing may cause marks or other damage near the selvages. Again, to allow for a considerable vertical movement of the cloth, a temple with rigid mounting must be set well back from the shed, to enable the cloth to rise and fall without damage to itself. But this necessary setting the roll back from the front of the shed is just what is not wanted, for the simple reason that it does not properly support the selvages to resist the drag of the filling or weft.

To secure proper templing it is necessary to have a mounting which will allow a roll to be placed close to the shed and move in every direction with its changes of position. In other words, the temple must rise and fall with the cloth and follow the reciprocating motion of the beat of the reed.

The original Swiss or Mathis temple, known in this country as the Kayser temple, had all the oblique pin rings and washers forming the roll, of the same diameter. This construction caused most of the work to be done by the pin ring nearest the end of the roll toward the center, or farthest from the selvage, because this first takes the strain, and the pins were liable to leave prominent and objectionable markings on many classes of goods. To avoid this, many devices have been tried, of which the most simple and successful is tapering the roll by making the pin rings and washers of successive smaller diameters. It is obvious that the ring nearest the end, or the smallest ring, will draw least and the largest one most; this equalizes the draught of all the rings, and entirely prevents

marking or tearing the cloth, and leaves an almost perfect selvage. Our new pattern for light dress goods is made of smaller size and is giving satisfaction where it is in use.

The ingenious arrangement for sliding the head of the temple back, in case it strikes the shuttle or for any other reason, effectually prevents any damage, and is most convenient for removing the roll for examination or other purpose. The slots in the washers between the pin rings forming the roll keep the rings free from dirt or grease; therefore they never stick and seldom need renewing.

The Hardaker Patent Temple is a great advance over any temple previously made for woolen and worsted fabrics. It is readily adjustable, self-acting, not liable to damage or excessive wear, and rises and falls with the cloth and follows the reciprocating motion of the beat of the reed.

DIRECTIONS FOR APPLYING.

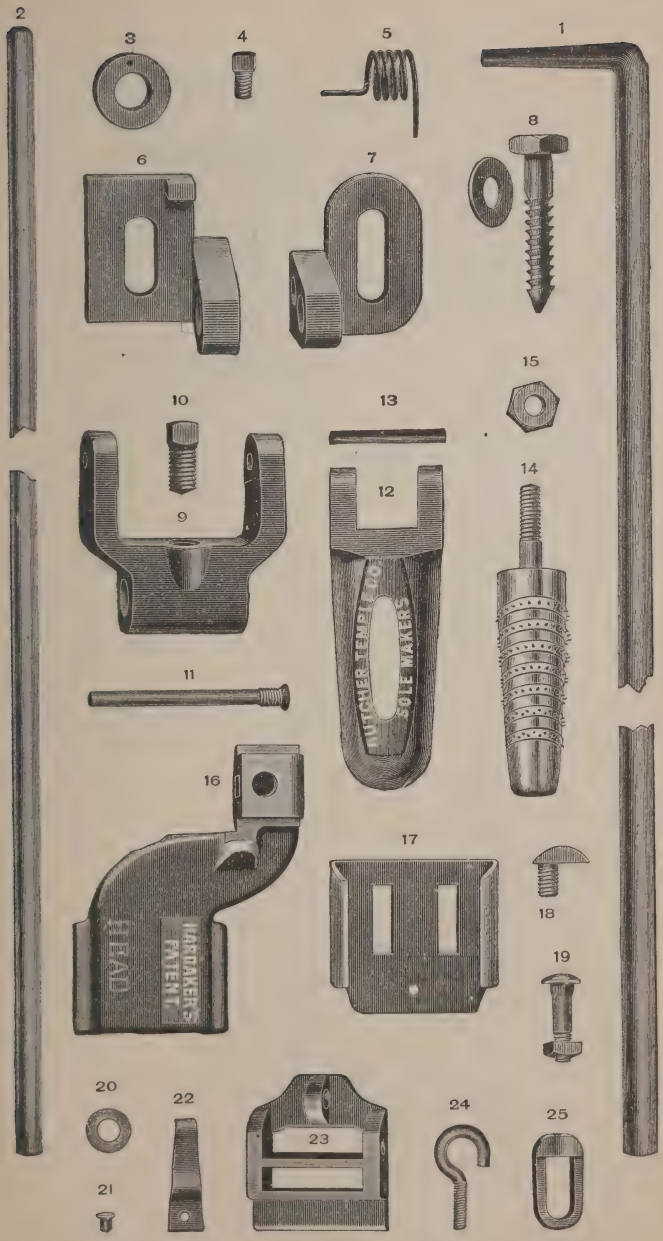
Set brackets flush with top of breast beam. End of rod with spring and collar must be at outside, and bracket set out to full width of reed. The stirrup should be set perpendicular, or leaning a little forward. The head should be set nearly level or it may lean toward the lay to suit the kind of goods woven; it should also be set as near the reed as is safe and just above the race-board, so that it will clear the corner of the lay. The roll is adjustable in the head for giving more or less bind in the cap. The spring collar should be carefully adjusted on rod to give the temple the same length of movement that the cloth has over the breast beam. The upright pin in the spring end of the rod indicates the motion of the temple and also serves as a stop.

When weaving heavy goods with soft filling the temples should be set in three-eighths of an inch at each side to avoid excessive strain. For worsted or cotton-warp goods they may be set out to the full width of the warp.

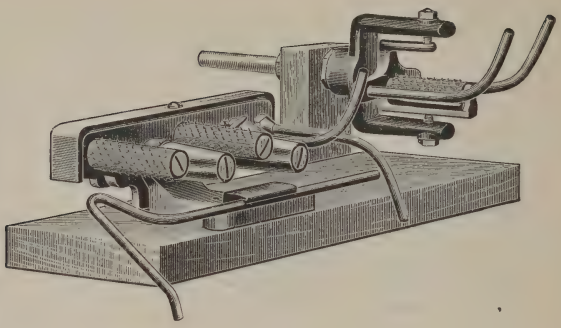
Technical Names of Parts.

1.	Large rod.	14.	Roll.
2.	Small rod.	15.	Roll nut.
3.	Collar.	*16.	Head.
4.	Collar set-screw.	17.	Head holder.
*5.	Spring for large rod.	18.	Lock-screw for top.
*6.	Outside bracket.	19.	Saddle bolt.
*7.	Inside bracket.	20.	Washer.
8.	Bracket screw and washer.	21.	Rivet.
*9.	Stirrup.	22.	Friction spring.
10.	Stirrup set-screw.	23.	Saddle.
11.	Saddle pin.	24.	Hook.
*12.	Top.	25.	Link.
13.	Top pin.		

*Parts marked with a * are made right and left.



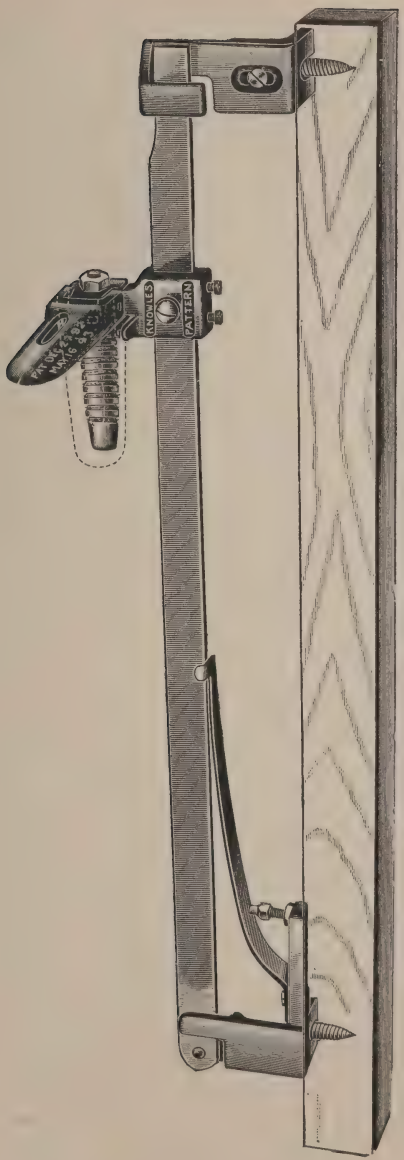
PARTS OF HARDAKER'S PATENT TEMPLE.



HOLLINGWORTH PATENT DRYER FEED.

We are now introducing an automatic feed for drying machines, which has met with considerable success, the labor saving results being of high importance, amounting to 50 per cent., by disposing of one operative where two were formerly necessary. The mechanism is more or less allied to devices used in templing cloth, as temple rolls are applied to engage the selvage of the cloth in the machine. Our feed is simpler than any other on the market, containing no oscillating or driven parts, and therefore nothing to replace, or get out of order. It can be applied to any chain dryer in use, and can be used on any kind of cloth usually passed through these machines.

We sell these machines on a guarantee, so that they may be returned if not satisfactory.



THE KNOWLES TEMPLE.

DUTCHER PATENT "KNOWLES" TEMPLE.

The Knowles temple is a modification of the Hardaker, especially arranged for application to the Knowles looms. It has less motion than the Hardaker, being only intended for open shed weaves.

TECHNICAL NAMES OF PARTS.

1. Bar.
2. Spring.
3. Swivel.
4. Inner Bracket.
5. Stop.
6. Outer Bracket.
7. Head.
8. Bracket Screw and Washer.
9. Tension Screw.
10. Head Screw.
11. Swivel Screw.
12. Top.
13. Top Pin.
14. Roll.
15. Roll Nut.
16. Spring Screw.
17. Lock Screw.

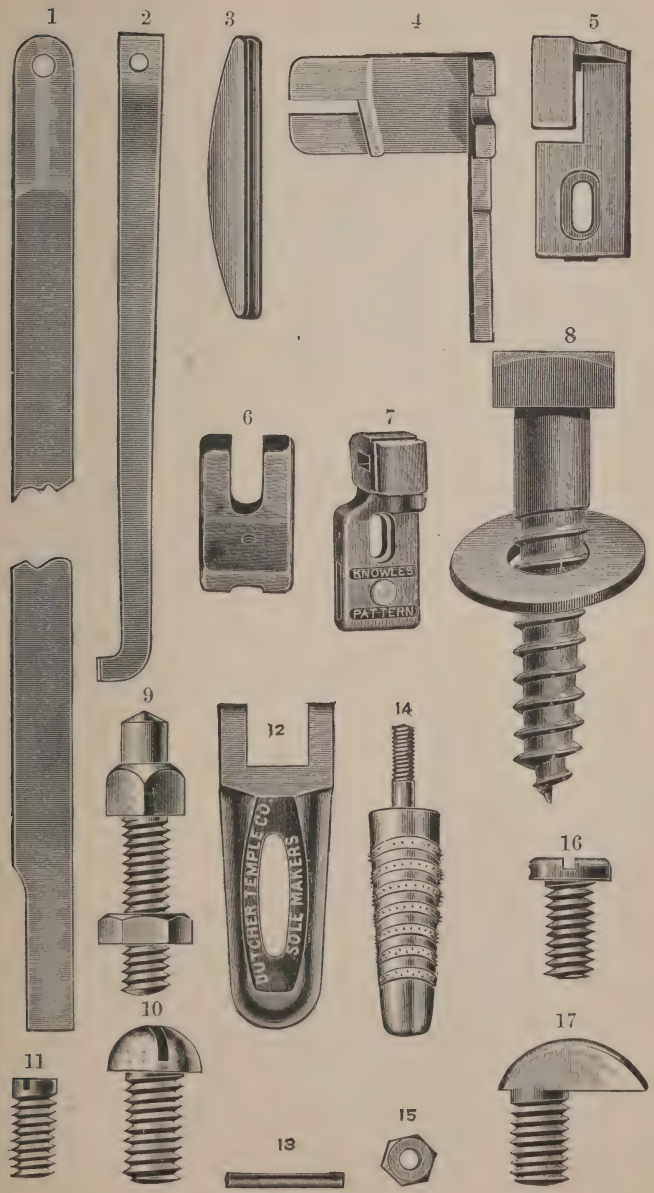
Parts 2, 4, 5, 7 and 12 are made in Rights and Lefts.

Parts 2, 4, 5, 6, 7, 12 and 14 are made in different shapes and sizes, and must be ordered by sample or by number on pattern.

The rest can be ordered by this list, as "Bar for Knowles Temple."

All cuts one-third size, but 8, 9, 10, 11, 15, 16 and 17.

Made with 5, 7 or 9 rings to roll as ordered.



PARTS OF KNOWLES TEMPLE.

THE DAWSON PATENT TEMPLE.

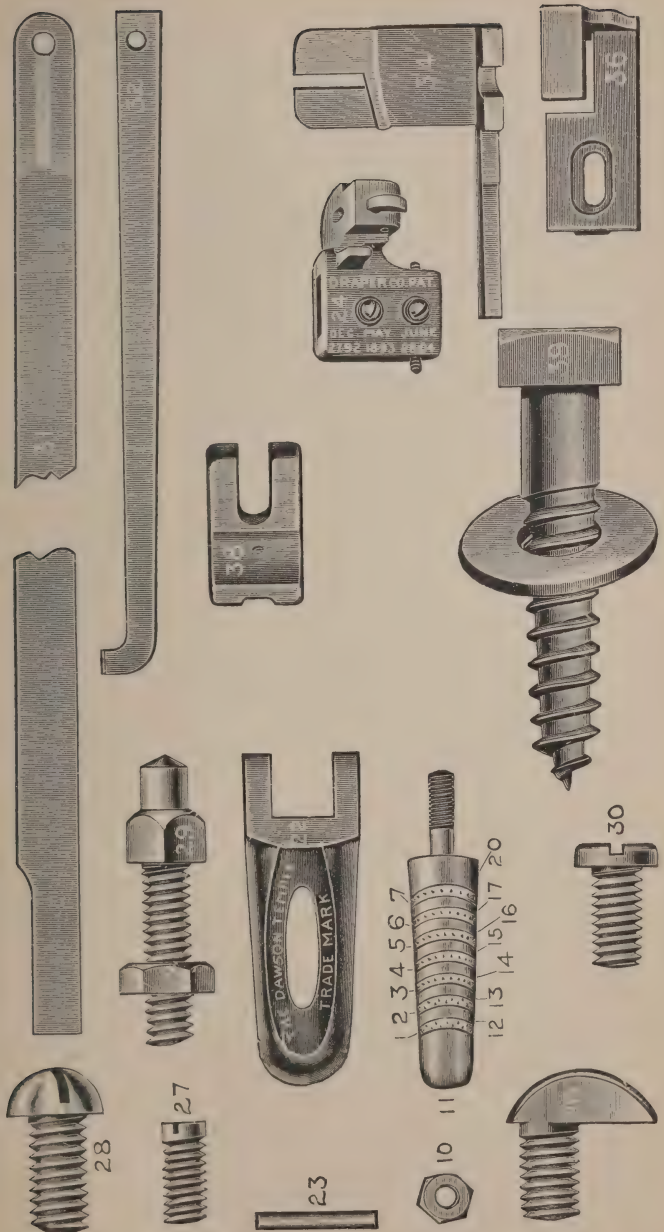
This style is quite similar to the Knowles pattern. We have purchased the business and patterns of the Dawson Temple Co. and are prepared to supply the temples or repair parts for the same on order.

TECHNICAL NAMES OF PARTS.

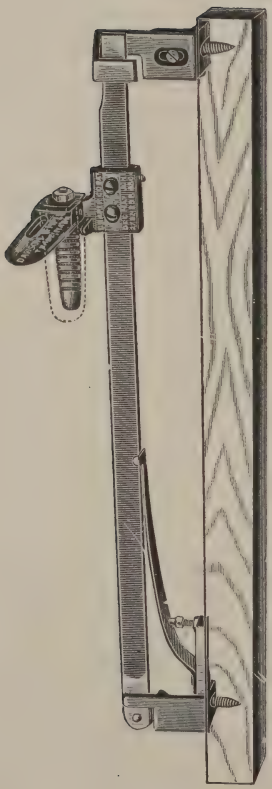
1, 2, 3, 4, 5, 6, 7. Toothed rings for roll of varying diameters.
8, 9. Numbers used for a 9-ring roll.
10. Roll nut.
11. Roll end.
12, 13, 14, 15, 16, 17. Roll washers of varying diameter.
18, 19. Numbers for extra washers on a 9-ring roll.
20. End washer.
22. Top.
23. Top pin.
24. Head.
26. Lock screw.
27. Swivel screw.
28. Head screw.
29. Tension screw.
30. Spring screw.
31. Bar.
32. Spring.
34. Inner bracket.
36. Stop.
38. Outer bracket.
39. Bracket screw and washer.

Parts 22, 24, 32, 34 and 36 are made in rights and lefts.

Parts 22, 24, 32, 34, 36 and 38 are made in different shapes and sizes, and must be ordered by number on pattern or by sample. The rest can be ordered by this list, as "*Bar for Dawson Temple.*"



PARTS OF DAWSON TEMPLE.



THE DAWSON PATENT TEMPLE.

PATENTS AND PATENTEES.

In our vocation of introducing cotton machinery improvements, we have necessarily had continued connection with a wide range of inventive talent, and as many of the readers of this work are gifted with that species of ingenuity, which discovers possible chances for improvement, it may be of interest to point out certain facts and necessities in this line. At present, we are primarily interested in improvements on the devices shown in this book, and usually refer suggestion in other lines to builders of the other classes of machinery. We are always interested, however, to note any really marked and important novelty in any **cotton machine** line.

While an invention is primarily a **new** method of accomplishing a desired result, it is of little value unless it points out a **better** method. The only object of patenting impractical, or inferior methods, is for purposes of protecting some other invention from competition, by a possible further development that would be of value. It is often difficult for an inventor to comprehend the fact that while he may have a decidedly new idea, he cannot necessarily use the idea, **if there is a patent already granted with a claim which covers his device.** Pioneer patents are often broad enough to absolutely prevent competition by devices for the same purpose, no matter how they may vary in design or combination of parts. It must be remembered that the courts usually recognize the value given to the world by the first introducers of a real improvement, so that it will not do to rely too strongly on possible evasion of technical language, or clever rearrangement of parts.

No invention is proved to be of great value unless it has actually accomplished its designed purpose, in an extensive, practical test. One spindle, or one loom, proves nothing, for a larger trial always develops defects which it is impossible to note in a single experiment.

Inventions in our line are usually in the direction of lowering the cost of the machine itself, lowering the cost of operation, or enabling it to turn out a greater product or a better quality of product. The most valuable inventions are those which can accomplish all of these results; although the question of the cost of construction is usually very immaterial, if the gain in other directions is noteworthy.

No invention can be protected by a patent, if it has been in public use for two years before the application. A patent is void if granted in the name of a man who is not the real inventor, and it is also void if patented in the name of several

parties, any one of which has not contributed an essential part of the invention claimed.

We inspect hundreds of inventions every year, which are sent to us in trust, and we fail to remember any case in which an inventor has ever claimed any breach of faith. It is, of course, embarrassing when several inventors send us the same idea. This often happens, as several men may discover a mechanical defect at the same time and think out the same method of cure. A large majority of the ideas sent to us are already anticipated by granted patents. We always prefer to acquire an invention before it has been patented, as we are unwilling to trust to the ordinary methods by which patents are obtained. It is impossible for the average patent attorney to grasp all the possibilities in any single line like this, for the majority of them have never been in a cotton mill, and few, of course, are educated as to the state of the art, or the detail of the necessities of operation. When we are not impressed with the patentability of an idea, we often notify the inventor that we will consider the matter **if he can get a patent;** but we fail to remember any such instance in which we were forced to change our view-point by the unexpected success of the owner under these circumstances.

The inventor must not make the mistake of considering himself entitled to all the value of his idea, unless he is willing to devote his own time and capital to its introduction. We expect to make a profit on our patent purchases, else there would be no inducement for us to continue in the business; and we must also make enough profit out of the successful inventions to pay for the many failures which are inevitable. In spite of our long experience, we probably make ten failures in trial for every successful idea introduced; and we certainly purchase more than ten worthless patents for every one that is found to be of the slightest value.

There is an erroneous impression current to the effect that an inventor is invariably cheated out of his rights, many people considering him as a rare and peculiar genius, to whom the the world will owe a large share of its progress. If such judges could witness the steady stream of inventors to our office, and read our correspondence, they would possibly change their views; for inventors are numbered not by the hundred, but by the thousands and tens of thousands. This talent is measured, like every other commodity, by the law of supply and demand; and no inventor is forced to sell his ideas, in this free country, if they are not valued to his liking.

Any man who notes defect in machinery under his charge, and reasons out a way to better it, should certainly endeavor to have the idea put into practical use.. It is not advisable,

however, for those who are naturally expected to devote their time to some regular occupation, to devote their entire thought to possible mechanical combinations, in the hope of chancing on some salable idea. Few can afford to make invention their sole occupation, and such must be trained by a long experience and education in the work of designing and experimenting, before their continued service in this field can be of value. Many a man has wrecked his career by taking up invention as an occupation because he has hit on some one good idea. Ingenuity in itself is not sufficient qualification, for the impractical ideas often contain the highest grade of cleverness. Impracticality often lies in devising methods that are in advance of necessity and not adapted to the intelligence of the help available. Ingenuity must join with caution and common sense to be of commercial utility and commercial value.

The honest endeavor to improve and possibly profit by recognition of value invoked is unfortunately often paralleled by an endeavor to weaken the strength of a pioneer invention by mere evasion, in the endeavor to levy tribute from the controlling element or to share in the profits developed by the newly awakened public demand. While there may be a gambler's chance for gain, the usual result is loss of time and loss of funds. With so many chances for improvement there is no excuse for waste of creative thought in mere attempt at imitation.

To January, 1907, we, with our predecessors and associates, have at various times owned or controlled some 2,070 patents. 740 of these have expired, leaving a net 1,330 active at the time of writing. We also have a large number of patent applications in the Patent Office at Washington, and many others in course of preparation. Several years ago, in making a comparative list, we found that we were apparently entitled to rank second in the number of patents annually taken out and assigned to our Company, the General Electric Company leading. The various Westinghouse Companies and private interests were a strong third. There was a considerable gap between these three and those next in order, the next group containing such large concerns as the International Harvester Company, National Cash Register Company, Western Electric Company, National Tube Company, Crompton & Knowles Loom Works, United Shoe Machinery Company, etc.

An inspection of the report for 1905, which is the latest one available at the time of writing would show that the General Electric Company is rapidly increasing its patent business, and the Westinghouse Companies, as a whole, have probably passed ourselves. In view of the much greater business done by these great electric companies, however, it is evident that

we do a much larger patent business in comparison with the size of our business, and the size of our product. We have been in this particular line of business much longer than any of the concerns mentioned, so that our record is really unique of its kind.

HOPEDALE INVENTORS.

The majority of the useful ideas adopted in our machinery are naturally of home origin. The following list gives the number of patents turned over to Hopedale interests by those who have been directly employed at any time by our various organizations and their predecessors up to Jan. 1, 1907. Several of those named have invented before or after employment here and not assigned such patents to us, so the list does not necessarily show the total sum of inventions per individual. While quantity is no test of quality, it presumes a prolific creative power at least.

Adolphson, G.	1	Draper, E. S.	4
Allen, N. I.	13	Draper, G.	42
Allen, W. E.	13	Draper, G. A.	12
Ambler, G. B.	1	Draper, George Otis	100
Anderson, J.	6	Draper, I.	2
Bailey, C. L.	2	Draper, W. F.	82
Bancroft, J. B.	14	Dunn, H. L.	1
Bancroft, W.	6	Durkin, D.	6
Beardsell, A. W.	3	Dutcher, F. J.	5
Bigelow, M. J.	3	Dutcher, W. W.	20
Bracken, H. W.	8	Edmands, A. B.	8
Burgess, G. M.	4	Edmands, Geo. D.	6
Burton, J. L.	3	Emery, A. D.	3
Burtt, A. E.	1	Entwistle, T. C.	7
Carroll, W. T.	44	Fay, R. C.	9
Cashman, J. F.	1	French, C. H.	1
Chapman, N.	12	Gifford, A. T.	2
Chase, C. E.	1	Goulet, J. A. G.	1
Clement, A. W.	5	Gray, J. R.	9
Coppinger, M.	1	Hawley, C. T.	5
Cottrell, J. D.	3	Haynes, W.	3
Cunniff, E.	3	Howard, C. S.	1
Darling, E. A.	1	Keeley, J. W.	2
Davenport, E. W.	4	Knight, G. W.	10
Davis, H. A.	1	Knox, C. I.	1
Day, C. M.	13	Jamieson, R.	3
Dixon, W. L.	1	Lawrence, H.	5
Draper, C. H.	18	Lovejoy, C. E.	3

Mahoney, D. D.	1	Searles, H. F.	1
Marcoux, A.	8	Sherman, M.	2
Mason, E. P.	3	Shorey, S. S.	1
McCleary, W. E.	1	Smith, C. A.	1
McCullough, P. E.	1	Smith, J.	1
Metcalf, C. E.	8	Southwick, W. S.	1
Morse, A. D.	1	Stafford, A. E.	6
Norcross, F. E.	1	Stimpson, E. S.	70
Northrop, J. H.	103	Stimpson, W. I.	18
Northrop, Jonas	42	Tarr, G. L.	1
Nutting, C. E.	9	Thompson, F. H.	3
O'Connell, P. J.	2	Thwing, A.	1
Prest, J. E.	14	Waite, O. E.	2
Rhoades, A. E.	53	Walker, R.	2
Robbins, E.	3	Walmsley, J.	3
Roper, C. F.	66	Welch, W.	4
Roper, W. F.	3	Whitmore, F. A.	4
Russell, C. W.	1	Wood, E. S.	19
Sadler, W. H.	1	Wright, D.	3